ON THE

SUSPENSION OF VITAL ACTION,

IN CASES OF

DROWNING AND *SUFFOCATION*, &c.

Adorned with an elegant Portrait of His Majeſty,
Patron of the Royal Humane Society.
And two other plates
Expreſſive of Apparent Diſſolution, and Returning Animation.

HOC PRETIVM CIVE SERVATO TVLIT

Painted by T. Gainsborough R.A. *Engrav'd by D. Lizars.*

GEORGE 3^{d}. KING of GREAT BRITAIN, &c.

PATRON of the ROYAL H. S.

A
NEW INQUIRY
INTO THE
SUSPENSION OF VITAL ACTION,
IN CASES OF
DROWNING AND *SUFFOCATION*.

Being an Attempt to concentrate
Into a more luminous point of view, the ſcattered rays of Science,
Reſpecting that
INTERESTING THOUGH MYSTERIOUS SUBJECT.

TO ELUCIDATE THE PROXIMATE CAUSE,
TO APPRETIATE THE PRESENT REMEDIES, AND
TO POINT OUT THE BEST METHOD OF RESTORING ANIMATION.

By *A. FOTHERGILL*, M. D. F. R. S.
Member of the Royal College of Phyſicians,
Honorary Member of the Medical Societies of LONDON,
EDINBURGH, and PARIS: Alſo of the
Philoſophical Societies of MANCHESTER, PHILADELPHIA, &c.

Vita brevis—Ars longa—Occaſio præceps—Experientia fallax—
Judicium difficile! Hipp. Aph.

BATH:
Printed by S. HAZARD, and ſold by Rivingtons, Dilly, Johnſon, and
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TO THE

KING's MOST EXCELLENT MAJESTY,

PATRON

OF THE ROYAL HUMANE SOCIETY.

LIKEWISE TO THE

RIGHT HONORABLE THE PRESIDENT,

THE VICE PRESIDENTS,

TREASURER AND REGISTER:

ALSO TO THE

MEDICAL ASSISTANTS AND DIRECTORS

IN GENERAL;

THE FOLLOWING INQUIRY,

AS A TRIBUTE OF SINCERE GRATITUDE AND VENERATION,

IS MOST RESPECTFULLY

DEDICATED,

BY THEIR MOST OBEDIENT SERVANT,

AND FAITHFUL COLLEAGUE,

THE AUTHOR.

421491

LONDON, SEPT. 17, 1794.

At a General Court of the *ROYAL HUMANE SOCIETY*, this day convened, for the purpoſe of preſenting the PRIZE MEDALS,

RESOLVED

1st. *That* Dr. A. Fothergill, *to whom the Gold Medal has been unanimouſly adjudged, be requeſted to publiſh his New Inquiry into the Suſpenſion of Vital Action.*

2ly. *That* Dr. Lettſom's *Oration, compoſed for the occaſion, and delivered at this Meeting, together with* Dr. Fothergill's *Reply be alſo recorded therewith, for the gratification of abſent Members.*

By Order of the Court,

W. HAWES, *Regiſter.*

Directions to the Binder concerning the Plates.

1. *The Portrait of his Majeſty to face the Title page.*
2. *Apparent Diſſolution to face P.* 92.
3. *Returning Animation to face P.* 168 *before the Appendix.*

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Publiſhed by order of the Royal Humane Society.

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DR. LETTSOM's ORATION,

Delivered before the Royal H. S. Sept. 17, 1794, *and Publiſhed at their Requeſt.——With Dr. F's Reply.*

ANY EULOGY ON THE PRESENTATION OF THE PRIZE MEDAL of the HUMANE SOCIETY to the ſucceſsful candidate muſt be defective as well as ſuperfluous—my acclamation is too feeble on a ſubject ſo intereſting to our very exiſtence, as, not only to aſcertain the proximate cauſe of death, but likewiſe to prevent its operation.

WHEN AN INTELLECTUAL BEING contemplates his own exiſtence, and how wonderfully he is made, *apparent death* muſt primarily have appeared as the *real extinction* of human life—when the HEART had ceaſed to act—the LUNGS to perform their functions—and ANIMAL HEAT ſeemed to be extinguiſhed:——Bold and elevated in his views muſt have been that man, who preſumed to imitate the power of Deity, in reſtoring life to apparently-dead matter!

TO SAY THAT THIS MAN is ſtill amongſt us is to felicitate not only the community, but the æra in which he realized his daring ideas—ideas at firſt ſlighted by the incredulous as viſionary; and when realized by doubling human exiſtence, by the envious, as only a ſurreptitious claim of a previous diſcovery.

So Columbus, when he firſt divulged his vaſt project of *doubling the globe*, was inſulted by incredulity; and, after he had added a *new*, to the *old* hemiſphere, was perſecuted by envy.—In like manner, when *the northern luminary*, Linnæus, created a new ſyſtem of Vegetable nature, he found on every ſide determined aſſailants; but, fortified by the energies of his capacious mind, he gave this reply—"*poſterity will decide*;" and pointing to ſome academic children at play—theſe, added he, will become our judges.——It is a ſentiment worthy of ſuperior minds, that every arrow, ſhot at an inferior enemy, diſhonours the arm that pulls the bow.

There was a time, many of us well remember, when the Humane Society was firſt inſtituted with a view *to reſtore life* after a complete ſuſpenſion of the animal functions, that not one of the Directors entertained the leaſt idea of the ſucceſs which later experience has moſt happily realized; and, as ſome proof of the novelty of this plan of beneficence—I repeat to this numerous and reſpectable meeting, what I then ſaid to its author; that, were *one life* ſaved within twelve months, it would eſtabliſh the Inſtitution, and amply compenſate every expence and ſolicitude attending this arduous undertaking.—Little did any man think, not even the founders themſelves, inflamed as they were with ſacred zeal, that, in the year 1794, there ſhould be recorded 3000 inſtances, wherein the SOCIETY'S aid had been extended, TWO THIRDS of which had proved ſucceſsful!

IN THE FIRST CASE OF RESTORATION I cannot but recollect with pleaſure, even at this time, the joyful ecſtaſy this ſingle inſtance of ſucceſs afforded.—How ineſtimable the redemption of a victim from a premature exit is, each of you GENTLEMEN well know, for each has lived long enough to lament the loſs of a beloved relative or friend;—but, who amongſt us poſſeſſes a mind, equal to eſtimating the accumulated rapture of *Chriſtian philanthropy* in contemplating the REDEMPTION OF THOUSANDS!

WONDERFUL AS HAS BEEN THE SUCCESS OF THIS INSTITUTION, in tracing its influence on other countries and people, the mind is farther gratified with the extenſion of humanity.—In the LAST REPORTS I obſerve the following ſtatement, which muſt inſpire a Britiſh heart with patriotic pride and pious exultation.

"THE

ROYAL HUMANE SOCIETY

May be juſtly conſidered as the Parent of all the HUMANE SOCIETIES eſtabliſhed in this Kingdom, Ireland, many parts of the Continent of Europe, in America, and the Weſt India Iſlands.

THE MANAGERS

Have not only tranſmitted the neceſſary information to form HUMANE SOCIETIES, but they have likewiſe, at an immenſe expence, preſented the Faculty, &c. with their Apparatus, Drags, Reports, and Plans of Reſuſcitation, reſident in the different Parts undermentioned:

Liſbon, Normandy, Vienna, Copenhagen, Algiers, Britiſh Settlements in the Eaſt Indies, Jamaica, Barbadoes, Hudſon's Bay, Boſton, Pennſylvania, and Philadelphia, Dublin, Limerick, Waterford, Londonderry, Belfaſt, Aberdeen, Montroſe, Sunderland, Liverpool, Lancaſter, Shropſhire, Cheſhire, Newcaſtle-on-Tyne, Whitehaven, Severn, Briſtol, Kent, Surrey, Darlington, Norwich, Newark, Worceſter, Horncaſtle, Shrewſbury, Leith, Northamptonſhire, Oſtend, and the Univerſity of Prague."

Gentlemen, I cannot reſiſt recalling your attention to the eſtabliſhment of a *Humane Society* under our auſpices at Algiers.—I repeat Algiers; for, it is ſurpriſing, and almoſt incredible, though indeed we know it as a fact, that in that barbarous ſoil *a ſpark of humanity* is at length kindled.—May it expand, illumine, and ſoften, the heart equally dark and callous!—What a grateful contraſt does this preſent of the Christian System to the barbarity of infidels.—In that land, where a Muley Iſhmael immolated with his own hands eighty of his relatives—the *amities of the goſpel* have led to an eſtabliſhment that ſaves the life even of a ſtranger!

Often have I reflected with pleaſure upon theſe indications of humanity, trivial as they may appear in this barbarous region; and as often have viewed our SOCIETY, with a ſacred and religious awe, as the ſource of good and beneficence, that cannot be eſtimated by the preſent generation.—We have witneſſed enough to encourage zealous perſeverance in its promotion.—*The little cloud, not a hand's breadth, has expanded even beyond our horizon.*—May it be diffuſed and expanded to the extreme limits of the univerſe!

THAT GREAT AND GOOD MAN, whoſe loſs was the common loſs of mankind, the Priſon HOWARD, in the unbounded expanſe of his benevolent mind, viſited CONSTANTINOPLE to view and reform its priſons, ſo as to alleviate the miſeries of the incarcerated objects.—His ardent zeal rouſed public attention, and gave riſe to various inquiries among the Citizens.—"Who is this MAN that quits home and friends to ſympathize with foreign diſtreſs?—What is that religion, that ſource of piety, which can excite and actuate the boſom of ONE to whom we are unknown but as fellow-men—thus to riſk his own life, and forego all its comforts, for our preſent and future happineſs!—"

THUS THIS PHILANTHROPIST aſſured me the people began to reaſon: and he truſted, after leaving *Cherſon*, to reviſit this metropolis of the Eaſt, to revive thoſe ſentiments and inquiries which his firſt interview had excited.—We know and lament that ſuch worth and beneficence was ſo ſuddenly loſt to the community:—

community:—Loſt did I ſay?—HIS NOBLE EXAMPLE may have raiſed, even in that torpid people, blinded by ignorance and prejudiced by fataliſm, ſome ſparks, yet to be kindled, by *another Howard*, or by the ſacred fire that inſpired a HOWARD!

EXCUSE, GENTLEMEN, this digreſſion; but I was carried away by reviewing the ſurpriſing and wonderful influence that ONE MAN has had in extending the benefits and ſpirit of this Society;—may his ſpirit deſcend to poſterity with redoubled energy!

HOWEVER PLEASING it may be for an individual to acquire merited applauſe, which our HUMANE SOCIETY has long and honourably beſtowed, where each of whoſe Directors, however, hath thrown his handful of mortar into the edifice of marble;—yet, in doing good from virtuous motives, a ſenſe of conſcious rectitude will ever afford the higheſt reward to the philanthropic boſom.

IN THE ARDOUR OF ZEAL—improvement naturally ſucceeds diſcovery:—ſo Dr. HAWES reaſoned, and with laudable exertions accelerated this good work, by propoſing honorary rewards, to ſtimulate genius, to elucidate his darling ſubject of Reſuſcitation, upon the moſt clear, certain, and irrefragable principles.

To doubt and to inquire will always lead to truth, which becomes more brilliant by diſcuſſion, as the diamond acquires luſtre by friction; ſo, in ſcientific purſuits, one diſcovery leads to another, and by degrees the mind is led on to the inveſtigation of not leſs uſeful than abſtruſe ſubjects, which would not be the reſult were the vivid glow of light to be at once diſplayed: for, one illumines and improves, the latter dazzles and confounds.—This ſentiment induced the celebrated FONTENELLE to ſay—"if both my hands were full of truths, I would open but one at a time."

Thoſe who can recal the commencement and origin of this Inſtitution, and the ſtate of knowledge acquired at that time, and next ſurvey the *preſent accumulation*, muſt experience ſingular pleaſure in tracing the *progreſs and evolution of ſcience* as connected with the ſubject of the Reſuſcitative Art, much of which may be aſcribed to the diſquiſitions which have reſulted from the HONORARY MEDALS. —I do not ſpeak my own opinion merely, but that of *Europe*—for, almoſt in every medical work, there are appeals to their judicious authorities as deciſive of the facts which they have eſtabliſhed, enforced, and illuſtrated.—Of this kind is the VALUABLE PRODUCTION, which has, at this time, brought together ſo many of our members and friends in the cauſe of active humanity.

It was once my deſign, to have laid before you an *analyſis* of this intereſting performance; but it exhibits ſo vaſt a fund of ſcience and uſeful information, that I found it impracticable to make extracts or an epitome with juſtice to the original Diſſertation.—— This, however, I regret the leſs, as I hope the Public will be favoured with ſo intereſting a work on SUSPENDED ANIMATION, by the ingenious author, to whom has been adjudged the *Prize Medal* of the HUMANE SOCIETY.——A REWARD the MOST HONOURABLE in its power to beſtow, and which is AS HONOURABLY ACQUIRED; but I ſhall not dwell upon a theme, to which, if my abilities were adequate, my feelings of pleaſure and joy crowd on too tumultuouſly, to allow me to give expreſſion:—I ſhall therefore now declare the deciſion of the COUNCIL of the MEDICAL SOCIETY.

THE DISSERTATIONS ON THE QUESTIONS having been read, and on a ballot being taken to determine their merits, the Prize Medal offered by the ROYAL HUMANE SOCIETY was UNANIMOUSLY adjudged to that, which had for its motto,

" *Vita brevis—Ars longa—Occaſio præceps—Experientia fallax—Judicium difficile!* "

THE SEALED PACKET BEING OPENED, IT WAS DISCOVERED, THAT ANTHONY FOTHERGILL, M. D.—F. R. S. of Bath,

is the author of the ſaid diſſertation.

YOU, GENTLEMEN, who have been formed in the ſchool of philanthropy, know how to eſtimate the enjoyment of friendſhip, and will participate with me in the pleaſure of preſenting your medal to one of the moſt amiable of men—to ONE who has for many years contributed to augment my felicities of life, whilſt he diminiſhed its ſolicitudes; and whoſe virtues, and erudition, I could with pleaſure long dwell upon at this time, were they not univerſally acknowledged, and forbidden by his preſence.

In the name of the HUMANE SOCIETY, and in conformity to the adjudication of the MEDICAL SOCIETY, I preſent this GOLD MEDAL, with the following inſcription, as a reward for the BEST ESSAY on the queſtions propounded in the year 1792, to DR. ANTHONY FOTHERGILL.

On the Exergue,

LATEAT SCINTILLULA FORSAN.

Round the Medallion,

PROPTER VITÆ SCIENTIAM FELICITER AUCTAM.

Within the Wreath,

OPTIME MERENTI
ERUDITOQUE
ANTONIO FOTHERGILL, M. D.—F. R. S.
1794.

Whilſt my illuſtrious friend, the friend of humanity, enjoys this juſt tribute of applauſe——may he perſevere in that path of uſeful ſcience, which devotes the acquirements of literature to the important intereſts of the health, and happineſs, of our fellow-creatures!

Dr. F——'s Answer.

Mr. VICE PRESIDENT,
AND
GENTLEMEN!

I am sensible—truly ſenſible—of the very distinguished honour, which the ROYAL HUMANE SOCIETY has this day ſo liberally conferred upon me.—This valuable donation, ſplendid in itſelf, acquires, if poſſible, additional ſplendor by paſſing through the hands of our munificent treasurer.*

Be assured, Sir, I ſhall ever eſteem this medal as a sacred—as an invaluable pledge, depoſited in my hands for the noble purpose of exciting a generous emulation amongſt our ingenious medical brethren.———The unanimity with which it has been adjudged—the generosity with which it has been beſtowed—and the politeness with which it has been preſented, equally claim my beſt—my warmest thanks!

To you, Mr. Vice President, I am *particularly* indebted for the *very elegant* though *too*

---

* Dr. Lettſom being Treaſurer as well as Vice Preſident of the R. H. S.

flattering

ſlattering encomium, juſt now delivered in your EXCELLENT ORATION.

May the ROYAL HUMANE SOCIETY and the LEARNED MEDICAL SOCIETY of LONDON ever flouriſh--ever remain—the DISTINGUISHED PATRONS of HUMANITY—and of SCIENCE!

And may YOU, Mr. *Vice Preſident*, long live—to co-operate with them, in their laudable and beneficent undertakings--to animate them by your example—and to participate with them in the ampleſt manner, THE SUPREME—THE EXALTED PLEASURE

of

PRESERVING HUMAN LIFE!

CORRIGENDA.

Page.	Line.	
56	19	Omit *No.* 30.
59	27	Hints on Animation occaſionally referred to, we now learn, have been ſometime out of print.
64	24	Omit *the preſence of.*
77	24	For *is this* read *is it, &c.*

Entered at Stationers Hall.

INTRODUCTION.

VARIOUS indiſpenſable avocations have contributed to delay the preſent PUBLICATION, and have conſtrained the Author to treſpaſs on the SOCIETY's patience until now. During the interval, however, the Work has been carefully reviſed throughout; many paſſages have been retouched, others illuſtrated, and, it is hoped, not without receiving PROPORTIONABLE IMPROVEMENT.

Should the whole now be found more worthy the peruſal of the enlightened Reader, the Writer will think the additional labour extremely well beſtowed.

Previous to the origin of this new branch of healing (which indeed conſtitutes a remarkable æra in Science), death apparent and abſolute had long been conſidered as almoſt ſynonymous terms. For the ſubjects of both, appear to have been alike conſigned to the ſilent manſions of the tomb, without its being ever dreamt that ſuch a vaſt proportion of the former, might, by a few ſimple means, have been recalled to life, and all the endearments of ſocial happineſs. Of the truth of this important fact, however, the Tranſactions of this Society have, from time to time, afforded the moſt ſatisfactory demonſtration. Since, in addition to the very pleaſing account juſt delivered by the Treaſurer, we have the following ample confirmation from the Regiſter.

"The HUMANE SOCIETY have reſtored to the Public MORE THAN TWO THIRDS of thoſe who would otherwiſe have been interred as inanimate beings.

1. Among theſe, many were the HEADS OF FAMILIES, who would have become a parochial charge had not their lives been thus preſerved!

2. Many were HEEDLESS INFANTS wandering from their parents, who, but for this inſtitution—would never have returned!

3. Others were SUICIDES ruſhing into Eternity, in a ſtate of mind the moſt unfit to appear before their JUDGE!"*

The numerous humane Inſtitutions to which this has given birth, have alſo annually contributed their reſpective *quota* of happy reſtorations, from apparent diſſolution.

Theſe infant ſocieties, like ſcion plants, having ſucceſſively ſhot forth from the parent ſtem, have been carefully tranſplanted into various climates, and remote regions, where, we rejoice to find, they have not only taken root, but flouriſhed; nay, even in the inauſpicious ſoil of Barbary!

Great indeed muſt be the number of perſons who, have either directly or indirectly, been preſerved by the diffuſive energy of the Royal H. S.!

But how much greater ſtill would be the amount, ſhould we attempt to calculate (which would be but reaſonable) not only the perſons reſcued, but the probable progeny deſcending from them, through ſucceeding generations!—

Though no conſideration, of this nature, can fully compenſate for thoſe dreadful ravages of war, by which myriads of human beings are periodically ſwept from the face of the creation!—yet the remnant thus daily preſerved to the community, and that in an increaſing *ratio*, muſt ever afford the moſt heartfelt conſolation to the humane part of mankind, who "ſeek not to deſtroy life, but to preſerve it."

No ſooner had the Humane Society ſurmounted the firſt difficulties inſeparable from ſuch a novel undertaking, than it not only fixed the attention of the Medical Faculty, but alſo attracted the notice of the Poet, the Painter, the Philoſopher, and the Divine By ſuch collateral aid, but ſtill more by the uncommon exertions of ONE INDIVIDUAL, has this inſtitution at length happily ſilenced all objections, triumphed over prejudice, and diffuſed its benefits over a conſiderable part of the known world.

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* Tranſactions of the Royal H. S. 1795.—p. 432.

The Society will inſtantly recollect that the individual here meant can be no other than their Worthy Regiſter, or rather INSTITUTOR—Dr. HAWES—To whoſe unremitting zeal and activity, aided by a LETTSOM-A-COGAN, and a few other CONGENIAL CHARACTERS, the Society owes its EXISTENCE.

He, undoubtedly, was the firſt, in this Country, who undertook to deliver a courſe of LECTURES on SUSPENDED ANIMATION——which was no eaſy taſk at that early period.—He alſo firſt propoſed HONORARY PREMIUMS for the farther elucidation of the Subject. To him, as the EVER ACTIVE AGENT, may in a great meaſure, be applied that emphatic expreſſion of the CELEBRATED LINNÆUS, who (on witneſſing the ſuperior activity, zeal, and energy, which diſtinguiſhed London, beyond every other city he had viſited) exclaimed with rapture,

" *Punctum vitæ in vitello Orbis!* " *

If ſuch has been the progreſs of the preſent inſtitution, in its early ſtages, what may not be expected, now that Philoſophy holds up the torch to medicine, to illumine its votaries, and direct their courſe in this new path of ſcience!——A ſcience, no leſs difficult, than it is ſublime and important; involving at once, the moſt intricate problems, in Phyſiology, Pathology, Chemiſtry, and Pneumatic-philoſophy!—Calculated not leſs to exerciſe the keeneſt faculties of the head—than to intereſt the fineſt feelings of the heart!

It is impoſſible for phyſicians of ſuſceptible minds to contemplate the affecting ſcene which the tranſition from apparent diſſolution to returning animation preſents to their eyes, without experiencing the tendereſt emotions of ſympathy.

What tranſport then muſt it afford every compaſſionate boſom, to be inſtrumental in recalling a helpleſs fellow-creature from an untimely grave!—To witneſs, at that critical juncture, the heartfelt paſſions of anguiſh and deſpair—of hope, fear, ſurpriſe, and joy, which alternately agitate the human frame! To mark the lively traits of gratitude painted in the countenances and deportment of the mothers, ſiſters, brothers, &c. of the reſtored object! What epicure could ever yet boaſt ſo refined, ſo exquiſite a luxury as the benevolent deliverer muſt experience from ſuch a ſcene!—a ſcene far beyond what any pen has yet been able to deſcribe—or pencil to expreſs! * This humane Inſtitution therefore, has one peculiar excellence, that ſeems to have been generally overlooked, which is to call forth, in the completeſt manner, the moſt endearing affections of the human ſoul—Affections, which ennoble the Species—and exalt humanity!——

On the preſent intereſting, but truly recondite ſubject, much has been already diſcovered—but much ſtill remains to be explored.—

In the proſecution of this laborious undertaking, as in the arduous attempt to aſcend the Andes, no ſooner have we joyfully gained the overſhadowing ſummit, which bounded our view, than the horizon widens, and diſcloſes ſtill higher eminences, which oppoſe freſh obſtacles to our progreſs!

> "*Hills peep o'er hills——and Alps on Alps ariſe.*"
>
> Pope.

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[*] This however, has been attempted by our ingenious Artiſt, and not altogether without ſucceſs.—See Plates, p. 92 and 168.

Diſcouraging as ſuch difficulties may appear, they are by no means inſurmountable. Though they may ſerve to inſpire diffidence, and check preſumption, yet inſtead of creating deſpondency, they ought rather to ſtimulate our ardor, and renew our zeal.

In the following inquiry, our Readers muſt not expect to meet with a new ſeries of experiments on brute animals, though ſuch may ſeem ſtill wanting towards the farther elucidation of the ſubject. But the extreme reluctance that is naturally felt, on ſubjecting harmleſs creatures to a painful, or lingering death, has of late deterred the Author from proſecuting that unpleaſant mode of inveſtigation: For dear is that knowledge, which is not to be purchaſed but at the expence of humanity!

For theſe reaſons, he has contented himſelf with drawing inferences from the experiments of others, ſo far as circumſtances ſeemed to warrant; and that without adding to the number of innocent victims.

Nevertheleſs, while hecatombs of inoffenſive animals are daily ſacrificed, partly to ſatisfy dire neceſſity, and partly to pamper human luxury, Practitioners may reaſonably demand, why may not a few be devoted to medical improvement? True—to real medical improvement—but not to idle curioſity, which can in no wiſe, be productive of utility, much leſs atone for cruelty.

Though Man conſiders himſelf as inveſted with abſolute dominion over the animal creation, yet ought he to exerciſe it with great moderation. Can he, as an accountable being, ſeriouſly believe he ſtands juſtified in wantonly taking away that LIFE, which it is not in his power to beſtow?

But independent of this conſideration, concluſions drawn from experiments on other animals, though performed with the utmoſt accuracy, muſt ever be liable, when transferred to the human body, to extreme uncertainty.

A foreign Experimentaliſt, of diſtinguiſhed talents, is ſaid lately to have performed upwards of 6,000 experiments on live animals, principally with a view to aſcertain whether poiſons act on the nerves, or on the blood! Though the reſult inclined him to the latter opinion, yet he was obliged to leave the matter extremely doubtful; candidly acknowledging at laſt, that his experiments were ſtill TOO FEW to afford demonſtration!

Such patient zeal, and perſevering aſſiduity, in the cauſe of experimental philoſophy, might command our admiration, were not the utility of the inquiry greatly overbalanced by the cruelty. Nature, we now ſee, cannot always be compelled to diſcloſe her ſecrets, though put to the moſt excruciating torture.

It were greatly to be wiſhed then, that theſe unavailing ſeverities might in future be mitigated, and that the phenomena in the human body, not only during the ſuſpenſion of vital motion, but after its total extinction, might be more narrowly inſpected. For a juſt and impartial account of theſe, together with the apparent effects of the reſpective remedies, minuted down upon the ſpot, would certainly afford a more ſatisfactory kind of knowledge than mere analogical reaſoning drawn from animals of another genus.

In the courſe of the following inquiry, the Author has ſometimes been obliged, though very reluctantly, to withhold his aſſent from the doctrines of the lateſt and moſt reſpectable authors; yet this has neither originated from vanity nor caprice.

Should his own opinions, in their turn, prove erroneous, he ſtands open to conviction; and having no cauſe to ſupport but that of TRUTH, he will always be happy to obtain BETTER INFORMATION.

PRIZE QUESTIONS,

PROPOUNDED BY THE

ROYAL HUMANE SOCIETY,

For the Year 1792 and extended to 1794.

1. "*What is the proximate Cauſe of Death in the various Kinds of Suffocation*"?
2. "*What are the moſt judicious means to be employed to reſtore Animation*"?

SECT. I.

Preliminary Obſervations on Life, and the comparative Faculties of Man and other Animals.

BEFORE we attempt to determine concerning the proximate cauſe of Death, we ſhould endeavour to aſcertain wherein Life conſiſts: But this involves the doctrine of the Soul—and might lead us into an abſtruſe metaphyſical diſquiſition, without reflecting much light on the main queſtion. Inſtead, therefore, of entering deep into the controverſy, we ſhall content ourſelves with taking a ſhort view of the general reſult. This we know, that Man has a ſentient principle exiſting within him, which thinks, reflects, combines ideas, and performs various operations apparently incompatible with any modification of matter hitherto diſcovered. And with this knowledge, I apprehend we muſt at laſt endeavour to reſt contented. For if this ſentient or thinking principle be immaterial, it cannot be an object of our ſenſes; and if it be not an object of our ſenſes, it will probably ever elude our keeneſt reſearches.

In attempting to trace this myſterious principle to its local habitation in the human frame, the ableſt philoſophers have ſtrangely bewildered themſelves; and after all their mental toil and random, conjectures have never yet been able to draw aſide the impenetrable veil. Thus ſome have pretended to have diſcovered its reſidence in the Pinæal gland, near the centre of the brain, others in the ſtomach, while others again have placed it in the heart, or diffuſed it over the whole ſyſtem. Our modern Materialiſts, equally unſucceſsful in their reſearches, and utterly unable to fix its reſidence, have boldly denied its exiſtence, and reſolved all the phenomena of mind into mere mechaniſm, or the reſult of certain imaginary vibrations.

To avoid the inconſiſtencies of their predeceſſors, they have run themſelves into greater, and have been obliged to attribute new and unknown properties to matter. Thus inſtead of ſolving the Gordian knot, they have raſhly cut it aſunder. For what are theſe pretended vibrations but a *petitio principii*—an illuſtration of the "*ignotum per ignotius?*"

ignotius?" Are the nerves to be conſidered as elaſtic cords which perform the vibrations, as the Æolian harp emits ſounds, without an intelligent Agent? The ſtructure of the nerves being deſtitute of elaſticity warrants no ſuch idea. Nay, even admitting their hypotheſis concerning the non-exiſtence of the Soul, and ſuppoſing Man a mere ſenſitive animal, compoſed indeed of ſomewhat *finer clay*, and of more exquiſite mechaniſm than the reſt of the brute Creation, yet they would ſtill find it no eaſy matter from thence to explain the amazing diverſity obſervable in the intellectual powers of Man compared with other animals, or with individuals of his own ſpecies. For were they to inſpect with the utmoſt nicety, the brain of a Newton, of an Idiot, and even of an Ape, they would probably find ſuch a ſtricking ſimilarity in the mechaniſm as might ſeem ſufficient to humble their pride, and put their whole fraternity to the bluſh. How muſt they have been confounded, had they lately been preſent when the French Chemiſt analyzed the Brain of a man and of a calf, to find the reſult ſo very ſimilar in both!

While Spinoza and his followers deny the exiſtence of the Soul, other metaphyſicians make ample amends, by allowing Man to be poſſeſſed of three ſeparate Souls—viz.

1. The rational, which they hold to be divine,

and

and infuſed by the breath of the Creator. This they term the Spirit, in which they ſuppoſe the intellect and will to be ſeated.

2. The ſenſitive, or irrational Soul, which Man has in common with brutes, and which is formed of the ordinary elements, in which they apprehend the paſſions and appetites reſide.

3. The Vegetative Soul or Principle of Life which Man has in common with plants.

The Epicureans held the rational Soul to be a ſubtile air. The Stoics, flame, or ætherial light —a third ſect maintained it to conſiſt of the ſame material ſubſtance with the Body.

Notwithſtanding their warm controverſies concerning its Eſſence, they all ſeem to agree in referring it to matter more or leſs ſubtilized—and therefore, at bottom, may all ſtrictly be conſidered as materialiſts.

From ſpecious arguments drawn from their writings, and from a partial view of the phenomena in the animal and vegetable kingdoms, have certain diſtinguiſhed Philoſophers of the preſent day been led to adopt the ſyſtem of materialiſm.

"Perception and cogitation," ſay they, "neceſſarily reſult from the mechaniſm of the brain, as much as reſpiration and circulation follow of courſe from the ſtructure of their reſpective organs." To give their argument its full force, let us admit this for a moment, and alſo add, that the admirable ſagacity of brute animals and the diſcriminating faculties of certain plants, beſpeak a degree of caution and forecaſt not unworthy of intelligent beings; and yet to what principle can we refer theſe faculties, but to inſtinct or organization, any more than the movements of a watch to mere mechaniſm?

According to their doctrine, then, we are to confound the divine faculty of Reaſon with the impulſe of blind inſtinct, and conſider Man as differing from other animals, not in the *nature* but *extent* of his intellectual powers, and in all other reſpects, regard him as copartner with his fellow brutes the equal tenants of Creation. But ſurely they forget that the inſtinct of animals is extremely limited, and ſoon reaches its *ne plus ultra*. The Beaver and the Bee erect their cells with invariable exactneſs, but without knowing why, and without any attempt towards improvement; all their deſires centre in themſelves and their offspring; and their paternal care ceaſes as ſoon as the latter are able to provide for themſelves: whereas Man's knowledge is progreſſive, each generation adds new diſcoveries to the general ſtock; then arranges the ſundry facts, and erects ſyſtem upon ſyſtem. His genius embraces all the objects of nature, and of art. His deſires are boundleſs. He comtemplates paſt, preſent, and future ſcenes, and carries his views beyond the confines of the viſible Creation. Anxious to tranſmit his name, and exiſtence to future ages, he ſtarts back with horror at the idea of annihilation. He *alone*, even in his moſt ſavage ſtate, poſſeſſes a moral and religious ſenſe, which enable him to diſtinguiſh right from wrong, and to pay adoration to a Superior Being.

To memory poſſeſſed by the brutes, he adds the higher faculty of Recollection. The former only preſents the written tablet, but the latter points to the very page.

The human intellect therefore appears to differ eſſentially, not only in *extent* but in *kind* from that of the moſt ſagacious animal.

If Mind is the neceſſary reſult of mechaniſm, it ought uniformly to keep pace with all the movements of the machine in ſickneſs, and in health. On the contrary, however, we often find that when the corporeal powers are ſtrongeſt, the mental faculties are weakeſt; that when the Soul's earthly manſion is decayed, and tottering to ruin, it begins to acquire new force, and to exert its faculties with a degree of energy, and preciſion unknown in health. Even during Sleep, while all the natural functions are ſuſpended, and the body aſſumes the image of death, the Mind, being diſentangled, remains active, and even contemplates objects with increaſed power and vivacity. Hence the Mind ſeems clearly capable of acting independent of the Body, and to demonſtrate a much higher origin, than that of the periſhable frame with which it is at preſent connected. Deſtined, we alſo know, after the Body has returned to its original duſt, to "flouriſh in immortal youth, to outlive the wreck of elements, and the craſh of worlds!"

Having thus briefly endeavoured to ſhew the fallacy of ancient and modern ſyſtems, reſpecting the nature of the human Soul—Their inconſiſtency in attributing the properties of mind to matter, and finally in degrading its higher operations to the ſame level with thoſe that proceed from mere inſtinct or mechaniſm, we ſhall drop this ſublime ſubject for the preſent; and by directing our future inquiries chiefly to Material cauſes, examine whether ſimple Vitality or ſenſitive Life, as enjoyed by Man in common with other animals, be yet rightly underſtood.

SECT. II.

VITAL PRINCIPLE—*Whether confined to the Blood or any particular Organ.*

Notwithſtanding the improved ſtate of Anatomy and Phyſiology, it does not appear yet to be abſolutely determined whether the vital principle exiſts in the ſolids or fluids, or even whether it is to be looked for as a ſeparate principle in any part of the œconomy. "Blood," ſays Moſes, (the moſt venerable Hiſtorian of Antiquity) "is the Life." It is by no means probable, that the Jewiſh lawgiver, at a time he was commanding the people to abſtain from blood, "becauſe the blood is the life," had any reference to the rational Soul of Man. Dr. Harvey, the celebrated diſcoverer of the Circulation, has gone farther, as appears from the following curious paſſage. "Nor is the blood to be called an original and principal part, only becauſe in it and from it, motion, and the beginning of pulſation ariſe; but alſo becauſe in it, animal heat is firſt bred, the Vital *Spirit* is produced, and in it the *Soul* itſelf reſides." *

In this opinion he hath alſo been followed by Dr. Willis, who endeavours to ſhew that the blood being itſelf *animate* is the entire ſource of the vital flame. And laſtly, by that able Anatomiſt, Mr. John Hunter, who alſo expreſsly pronounces the blood to be *alive*. Such an unqualified aſſertion maintained by anatomiſts of the firſt eminence, if once admitted, might not only lead to a concluſion, which probably they never dreamt of, but alſo prove productive of dangerous errors. For Life is allowed on all hands to be the attribute of an organized body alone, and if blood be an organized body, then is it an animal, and if ſo, here is a living animal deſtined to circulate within the veſſels of another living animal!

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* Harv. de Generatione Animalium Exercit. 51.

That the blood, though in itſelf a mere paſſive, inorganic maſs, performs many important offices in the ſyſtem will be readily allowed. It not only nouriſhes and ſuſtains all the ſolid parts, the brain, and nerves themſelves not excepted, but alſo contributes occaſionally to the reproduction of parts decayed, or loſt. Nay we may ſtill venture to add that the blood (for we mean not to deprive it of any vital honours to which it is fairly entitled) affords a perpetual and neceſſary ſtimulus to the heart, and vaſcular ſyſtem, without which animal life could in no wiſe be ſupported. In like manner air and water are eſſential to the nouriſhment of plants, without which the Principle of Vegetation would ſoon languiſh and expire. But does it follow that the fluid nouriſhing and ſuſtaining a living part muſt of neceſſity be itſelf alive? As well might we affirm that the milk, the bile, with all the animal and vegetable juices are alive; and that whatever ſupports the action of a ſenſible part muſt itſelf be ſenſible. Or as Dr. Johnſon, on a ſimilar occaſion, once ludicrouſly obſerved,

"For ſurely he that drives *fat* oxen muſt himſelf be *fat*."

Van Helmont and his followers conceived the principle of Life to be ſeated in the ſtomach;

others in the heart, as the grand centre of all the vital motions. Such indeed is the importance of both theſe organs, that no perfect animal with warm blood can ſubſiſt a moment without them. But certain cold animals can ſurvive the loſs of either of theſe viſcera for ſeveral minutes: the water Polype, without any thing even reſembling either heart, or ſtomach (unleſs a ſimple canal may be called ſuch), not only lives, but purſues its prey, and performs its various functions.

Nor have thoſe Philoſophers ſucceeded much better, who have placed the principle of Vitality ſolely in the brain. The famous Pinæal gland, in whoſe ſacred receſs they conceived the Soul to be enſhrined, has more than once after death been found replete with ſtony matter, and that without the Patients teſtifying during life any viſible defect, or derangement of the functions of that organ. The brain of an ox fatted for ſlaughter has been found in a petrified ſtate. A human fœtus has been born alive having only a few detached filaments of nerves in place of the ſpinal marrow, but without even a veſtige of brain.

The waſp, many minutes after it has been deprived of its head, ſtill continues to dart forth its ſting in various directions. The tortoiſe has been known to ſurvive this operation ſeveral months. Nay, what is perhaps ſtill more ſingular, the male toad, though decapitated in the act of procreation, yet ſuch is its affection, that regardleſs of the trifling loſs of its head, it deliberately completes the conjugal embrace! *

The principle of Vitality, therefore, does not appear to be ſeated in the blood or animal fluids; nor to have confined its reſidence to the ſtomach, the heart, or even to the brain, though parts, which phyſiologiſts have emphatically termed Vital organs. Where then ſhall we look next for this fugitive being? While we attempt to trace it to this or that organ, and perſiſt in conſidering it as a *ſeparate* living principle inhabiting ſome ſecret receſs of the ſyſtem, it will continue to elude the ſearch; and we ſhall probably at length be convinced, that philoſophers have been purſuing for many centuries paſt, a mere phantom of the imagination.

Conſidering the familiarity with which we daily contemplate Life in a variety of living objects, and obſerve the viſible difference between a living and dead body, and which, at firſt view, ſtrikes the moſt ſuperficial beholder, one would think there certainly could be no difficulty in diſcuſſing this ſimple queſtion—What is Life? or wherein does it conſiſt? How would the untutored peaſant ſhake his head at the philoſopher, who ſhould ſeem puzzled by a queſtion apparently ſo plain and obvious! And yet it may be doubted whether the acuteſt phyſiologiſt be yet able to anſwer it ſatisfactorily. One thing ſeems evident, that organization, or a ſuitable arrangement of diſſimilar parts muſt precede Life; but the latter is not to be conſidered as a *neceſſary*, only a *poſſible* conſequence of the former. Thus the watch may be complete in its mechaniſm, but unleſs it be wound up, or the main ſpring put in motion, it will for ever remain ſilent. The impregnated egg is ſuppoſed to contain, in miniature, the rudiments of the future chick, as the acorn does of the oak: but although the organization be complete in both, yet the chick would never be hatched without the animating heat of incubation, nor the oak expand its foliage without the vivifying influence of air and water. A well-formed embryo, whether animal or vegetable, may either not arrive at Life, or after it has been alive, preſently die, while the organization remains entire. Organization, therefore, is only a condition, or neceſſary ſtep towards animation.

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* Spallanzani, Hiſt. of Animals and Vegetables.

The learned Baron Haller very ably contends, that Vitality conſiſts in irritability, or that motory power of animal fibres, by which they undergo alternate contractions, on the application of a ſtimulus. On this ſimple principle he has beautifully illuſtrated the theory of the vital and animal functions. As an exception to this ingenious ſyſtem it muſt however be confeſſed, that certain animal ſubſtances, though entirely deſtitute of Life, teſtify apparent ſigns of irritability, ſuch as feathers, cat-gut, vellum, &c. Theſe, on being ſuddenly expoſed to heat, are inſtantly thrown into various irregular motions and contortions. Several light bodies are alſo put into viſible motion by the Electrical *aura;* and even particles of iron are compelled to dance to the magnetic influence. But theſe, and ſimilar effects reſulting from the power of attraction or repulſion, muſt not be confounded with the irritability of an organized body. This inherent property renders it ſuſceptible of being excited into action, but in addition to this, organic life further requires an harmonious arrangement of parts, and the influence of ſtimulating fluids ſpecifically adapted to the reſpective organs, in order to produce the functions of an animated being. When theſe circumſtances combine, the action that reſults appears to me to conſtitute the IMMEDIATE CAUSE of that condition, which we call VITALITY or Life, in its firſt or ſimple ſtate of exiſtence. Thus the *fœtus* in *Utero* indeed lives, but it is only the life of a vegetable, or, more properly, that of an aquatic animal; ſince like the tadpole it remains a breathleſs being, immerſed in a watery fluid till the moment of its birth, that it draws in air from the ſurrounding atmoſphere. Here a new and more perfect ſtate of Life commences, which viſibly actuates the whole frame. But this will be more fully explained, when we come to conſider the effects of reſpiration.

To the principle of irritability, which the infant inherits in common with animals, and even vegetables, the Creator hath ſuperadded to man a rational Soul. As ſoon as this begins to exert its energy, the faculties expand, reaſon gradually ripens into ſound judgment, and conſciouſneſs marks the man as an accountable being. Theſe and other mental endowments, as we have already proved, ſufficiently diſtinguiſh him from all other animals, and at the ſame time give him ſuch a decided preeminence, as enables him to exerciſe abſolute dominion over them. From whence, however, we may draw this inference, that Man ought to be thankful to the SUPREME DONOR, and merciful to his creatures.

Concerning the eſſence of the Soul, the intimate nature of irritability, and of that incomprehenſible chain which unites them both to an organized body, we are ſtill equally ignorant. Though we cannot doubt of their exiſtence, we can only trace them from their effects, juſt as we argue from the phenomena of Magnetiſm and Gravitation.

"*Cauſa latet—vis eſt notiſſima.*"

Life conſiſts in motion, and the animal machine, during its exiſtence, exhibits perhaps the moſt curious *Perpetuum Mobile* in Nature. All its vital motions proceed in a complete circle, of which we neither know beginning or end. Thus the heart and vaſcular ſyſtem propel the fluids, while theſe again ſtimulate the veſſels which contain them. Emotions of the Soul influence the Body, and bodily affections diſturb the Soul. The circulation of the blood imparts energy to the brain, and affections of the brain diſorder the circulation of the blood. Circulation in a great meaſure regulates ſecretion, and ſecretion circulation. The ſtomach ſympathizes with all the vital organs, and all the vital organs with the ſtomach.

We ſhall therefore only add in this place, that no ſooner is the "*Silver Chord* broken" which forms this ſingular connection between mind and matter, than the harmony of the whole is deſtroyed. Vitality ceaſes—the Soul quits its reſidence, and the Body, that exquiſite piece of mechaniſm, with all its movements, becomes a motionleſs, inanimate corpſe! The component parts of which ſoon undergo a decompoſition, and the goodly fabric mouldering into its native duſt, is afterwards diſperſed into its original elements!

SECT. III.

Suſpenſion of Vital Action from Drowning.

1. From various experiments, the following appearances have been obſerved to take place in drowning; to which particular attention ought to be paid, as they not only indicate the nature of the death, but the method which ought to be purſued to reſtore the vital motions.

When an animal is kept under water, it preſently begins to expel air forcibly from its lungs in form of bubbles which riſe to the ſurface. This is followed with a ſtrong deſire to draw in air, and in this effort it commonly inſpires a ſmall portion of water. Air is again emitted, and new efforts made to inſpire, and that with ſimilar effects. This is continued with increaſing uneaſineſs from 2 minutes to 5, when reſpiration ceaſes, faint gaſpings ſucceed, and it ſinks down motionleſs. Upon taking it out of the water, ſoon after all its ſtruggles are over, the noſe and mouth appear extremely pale, the eyes do not protrude, the pupils retain in ſome meaſure their natural luſtre, but are remarkably dilated. All ſenſe and motion, both external and internal, except a feeble contraction of the right ſide of the heart, are now loſt, and if ſuitable means of recovery be not made uſe of, the body gradually becomes cold, and with the loſs of heat, the heart by degrees loſes its power of contraction.

2. On opening the cheſt, the cavities of the right ſide of the heart with the correſponding veins are found to be diſtended with dark coloured blood through their whole courſe. The left ſide of the heart is often almoſt empty: alſo the large arteries, except the trunk of the pulmonary artery where it enters the lungs, which is commonly full of blood. The veſſels on the ſurface of the body appear empty, and the ſkin as pale as if the animal had been bled to death.

3. The lungs often appear unaltered, ſometimes in a collapſed ſtate; but if the animal is often ſuffered to riſe to the ſurface of the water, ſo that he may inſpire air, that organ appears diſtended. A quantity of frothy fluid, conſiſting of air and mucus, with a little of the water in which the animal was drowned, may generally be ſqueezed out of the windpipe. But this is ſmall in proportion to the quantity of air apparently expelled during the act of drowning, though it is more diſtinguiſhable when the animal is drowned in ink, or any coloured fluid. The orifice of the windpipe being endowed with exquiſite ſenſibility, the animal as if conſcious of the preſence of an improper element, rejects it with a convulſive kind of

horror. Theſe efforts to exclude water, and to draw in air, are alternately renewed till ſtrength is exhauſted, and reſpiration ceaſes. Hence the fruitleſs ſtruggles, which the animal exerts till it finally expires. After which, no more water probably is admitted; otherwiſe after the body has lain ſome time immerſed, we ſhould find the lungs fully diſtended, which is contrary however to obſervation. For it often happens, that no water can be diſcovered in the lungs of drowned animals. From the painful ſenſe of irritation which is felt on a ſingle drop of water, or other liquid accidentally falling into the windpipe, and from the convulſive motions which enſue till it is expelled, we may form ſome idea of this diſtreſſing ſituation.

4. In drowned animals, the heart retains its motion longer than any other part of the body. The motion of its right cavity ſurvives that of the left, and that of the latter holds out longer than the periſtaltic motion of the inteſtines, inſomuch that a weak pulſation of the right chamber of the heart often remains upwards of 2 hours after reſpiration has ceaſed.

On opening the head, the veins ſometimes appear rather diſtended, yet ſeldom more ſo than in other violent deaths, but without the leaſt appearance of extravaſation.

5. Upon the whole (2, 4.) it appears, that in

drowning, the organization of the principal parts remains entire; but that the heart, and large veins in its neighbourhood are diſtended with dark coloured blood, whilſt every other part ſeems in ſome meaſure to be drained of that fluid. Nor does the apparent fulneſs of certain veſſels in the brain, the blood-ſhot eye, the bloated countenance, or the lividity of the ſkin, ſo often obſerved in drowned perſons, who have remained long under water, eſpecially with their head downwards, prove any thing more than that the blood after death had deſcended by its ſpecific gravity to the more depending parts.

SECT. IV.

Suſpenſion of Vital Action from Hanging.

6. It appears from experiments, that when an animal is ſuſpended by the neck, it generally ceaſes to ſtruggle in about 5 minutes. The external veins of the neck being ſtrongly compreſſed, the return of the blood from the brain is partially interrupted, but continues to circulate in the internal veſſels while the action of the heart remains. The windpipe being ſhut by the preſſure of the

cord, and the ingreſs of air excluded, the eyes become prominent, the countenance grows firſt red, then livid, and ſuffocation enſues.

On inſpection of the body after death, the blood-veſſels of the brain and its membranes ſeem rather more diſtended than in the preceding caſe; the lungs very little altered, and free from frothy fluid: the heart, and trunks of the larger veſſels exhibit exactly the ſame appearances as in drowned animals. (2, 3, 4.)

SECT. V.

Suſpenſion of Vital Action from noxious Air.

7. Animal Life is often deſtroyed by expoſure to noxious air ariſing from fermenting liquors, from quicklime, or metals during calcination, from fumes of charcoal, from cloſe vaults, common ſhores, ſubterraneous caverns, wells of ſhips, &c.

Mines and coal-pits are frequently infeſted with two ſpecies of noxious air, ſimilar to thoſe abovementioned. The firſt termed by miners *Choke Damp* is native fixed air, generated in the bowels of the earth, which being ſpecifically heavier than atmoſpheric air, occupies the bottom of the mine.

The other called the *Fire Damp* is a native inflammable air, and being about 10 times lighter than common air, aſcends to the upper region of the mine.

8. Theſe pernicious vapours in their concentrated ſtate, being elements wholly unfit for the purpoſes of reſpiration, occaſion, the moment they are received into the lungs, an intolerable ſenſe of ſuffocation, and deſtroy animal life more ſpeedily than drowning or ſtrangulation. Noxious air in proportion as it is diluted with atmoſpheric air attacks the principle of irritability, in a more ſlow inſidious way, without producing any violent ſymptom. When the fire-damp, or inflammable air burſts out into actual flame, the miners are ſometimes dreadfully ſcorched, though in general, they are not burnt to death, as is commonly ſuppoſed, but ſuffocated by the vapour.

In moſt of the fatal caſes occaſioned by foul air, or by lightning, the poor ſufferers being generally imagined to be paſt all hopes, the means of reſtoration are too often wholly neglected.

Some of thoſe few who have been recovered from ſuffocation, occaſioned by the fumes of charcoal, deſcribe their ſituation as having been far from painful. That, on the contrary, at firſt a pleaſing kind of drowſineſs or delirium ſtole over their ſenſes, without leaving them even a wiſh to retire. This was preſently ſucceeded by an entire loſs of recollection.

9. The bodies of animals ſuffocated in noxious vapours, or killed by a ſtroke of lightning, exhibit the following appearances. Their limbs remain flexible long after death, except they are killed by nitrous air, in which caſe, they are ſaid to become ſooner rigid than thoſe deſtroyed by drowning, and that, ſometimes, even before the heart ceaſes to vibrate.

The eyes retain their luſtre, and the body a degree of heat often higher than the natural ſtandard. This is particularly obſerved of thoſe that are ſuffocated by the fumes of charcoal, and their blood, for ſeveral hours after death, remains fluid, and even highly florid. In thoſe, ſuffocated by fixed, and inflammable air, although the limbs continue pliant, the blood is leſs florid. In all; the veſſels of the brain are found turgid, the lungs little altered, the heart and adjoining veſſels equally diſtended as in thoſe that are drowned or hanged.

SECT. VI.

Suſpenſion of Vital Action from ſmothering.

10. Smothering, or Suffocation may be occaſioned by whatever ſuddenly obſtructs reſpiration. Thus infants through the negligence of the nurſe are ſometimes overlaid or ſmothered, particularly in folding-beds. Still-born children, through the ignorance or inattention of the midwife, are generally pronounced to be dead. Some of them, however, eſpecially ſuch as are upwards of 6 months old, might by proper means be happily reſtored to their afflicted parents.

In many inſtances of this nature, the tongue is drawn back into the throat, ſo as to ſhut down the Epiglottis, and to cloſe the aperture of the windpipe like a valve, by which the admiſſion of air is prevented. This may be eaſily remedied by drawing the root of the tongue forward, and by raiſing the valve with a finger. Should this prove inſufficient to enable the child to reſpire, ſuch other methods muſt be had recourſe to, as ſhall be mentioned in their proper place.

11. Incautious perſons, employed in digging ſand or gravel, are frequently ſmothered by the falling in of the ſuperincumbent ſtrata. Others are ſuffocated in cloſe ſtoves, or by being ſhut up

in confined air, contaminated by their own reſpiration, as happened to many of our Countrymen, in the black cell at Calcutta. Similar accidents ſometimes occur in the Diving-bell, for want of a ſupply of freſh air. The ſame thing happens to animals ſhut up in the exhauſted receiver of an air-pump.

12. Under all theſe circumſtances, where there is no fatal contuſion, the vital functions are ſuſpended merely from want of atmoſpheric air. The body is often found warmer than natural, the limbs pliant, the lungs nearly natural, the cavities of the heart, and large blood-veſſels diſtended with dark coloured blood. In other reſpects, the appearances are exactly ſimilar to thoſe occaſioned by drowning, or by noxious air (4—5.)

SECT. VII.

Reſult of Experiments reſpecting Vital Air—The Nature of Reſpiration—Its Effects on the Blood—Its Importance to Life, &c.

13. To what has been already hinted concerning the effects of reſpiration it may not be improper in this place to add the following obſervations, towards illuſtrating a function ſo eſſential to animation. Though reſpiration is a pro-

blem that has long perplexed the ableſt phyſiologiſts, yet it has been generally allowed on all hands, that no living creature can ſubſiſt without air. Whence is it then, that the unborn infant with its head like that of a drowned perſon immerſed in a watery fluid, not only lives, but grows rapidly, without any evident communication with the outward air? Or how comes it, that worms in various internal parts of the body—the toad in the centre of a rock or ſolid oak, and marine animals at the bottom of the ocean, live, without any viſible acceſs to this neceſſary fluid? Theſe exceptions might ſeem to afford inſuperable objections to the eſtabliſhed theory, reſpecting the importance of air to animal life. However, we ſhall find that inſtead of overturning it, they manifeſtly tend to ſupport it. Nature has wiſely adapted the internal ſtructure of theſe animals to the peculiarity of their ſituation—ſome to receive air directly into their lungs; others indirectly into the maſs of blood: others, again, to ſecrete air by a particular ſet of veſſels, when deſtined to live in water, inſtead of air.

The human fœtus, though ſurrounded with a fluid element, receives maternal blood fraught with air, by the intervention of the Placenta, which ſeems evidently to ſupply the place of lungs. Beſides, there can be but little demand for air by an animal that has not yet breathed.

Even rocks and trees, though apparently ſolid, are ſufficiently porous to admit air; beſides it is well known, that air may be extracted from them in conſiderable quantity.

That air is indiſpenſably neceſſary to breathing animals is evident from this, that no land animal can ſubſiſt in *vacuo*; no fiſh or aquatic animal in water previouſly deprived of its air.

14. It has been lately diſcovered, that the air we breathe, is not as was long imagined a ſimple element, but a compound fluid, conſiſting of 3 ſorts of air, poſſeſſing very different qualities, viz.

Azotic air, *Vital air*, and *Carbonic acid or fixed air*.*

One hundred parts of common atmoſpheric air are computed to contain the following proportions. viz.

Of Azotic air————————80 parts.
Of Vital air————————18 parts.
Of *Carbonic* air————————2 parts.

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* In conformity to the new chemical Nomenclature (now generally received), we have here adopted the modern terms, which however may require the following explanation.

The exiſtence of Phlogiſton is at preſent poſitively denied, (whether juſtly we preſume not to inquire) and ſince the various phenomena can be ſatisfactorily accounted for without it, the term is almoſt become obſolete.

Old Names.		*New Names.*
Phlogiſticated air,	*now termed*	Azotic air.
Dephlogiſticated air,	*now*	Vital air or Oxygene.
Fixed air,	*now*	Carbonic acid air.
Principle of Heat,	*now*	Calorique.

But theſe proportions vary in different ſituations, according to the purity of the atmoſphere.

It is remarkable, that the azotic and carbonic airs, conſtituting more than three-fourths of the atmoſphere, ſhould be found, when examined ſeparately, to extinguiſh both life and flame.

Vital air, on the contrary, is found by experiment, to ſupport an animal ſhut up in it, 4 times longer than an equal quantity of atmoſpheric air. If a lighted taper be immerſed in a jar of Vital air, it inſtantly burns with ſuch ſuperior ſplendor, as to dazzle the eyes of the beholder: * if conveyed into a jar of azotic or carbonic air, it as ſuddenly goes out. The experiment is equally ſtriking, if performed on live animals, by confining them alternately in theſe different kinds of air. Vital air, therefore, is evidently the true *pabulum* of life, and of flame. Without this vivifying principle in the atmoſphere, neither could animals breathe, nor fire be kindled. The world would conſequently ſoon become a comfortleſs deſert!

15. A gallon of common air by meaſure is found barely ſufficient to ſupport the perſon who breathes it, a ſingle minute. If a large bladder,

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* The brilliant balls exhibited in fire-works owe the whole of their reſplendent brightneſs to the Vital air of the nitre, let looſe by combuſtion.

The luſtre of the glow-worm is proportionally increaſed by Vital air, affording light ſufficient to read by in the darkeſt room.

der, containing this quantity of air, be alternately drawn into the lungs through a tube, and expelled back into the bladder, before the minute is expired, a ſenſe of oppreſſion or ſuffocation enſues, which preſently renders it neceſſary to forego the experiment, and to breathe freſh air.

If the air in the bladder now rendered unfit for breathing be chemically examined, it will be found that the Vital air has vaniſhed, that the carbonic air is conſiderably increaſed, and that the azotic air remains the ſame as at firſt.

If a candle is ſuffered to burn out, or an animal to putrefy in the like quantity of common air, it produces ſimilar effects. Hence reſpiration, combuſtion, and putrefaction equally tend to conſume the Vital air, and to increaſe the carbonic air. After this, the air becomes equally incapable of ſupporting life, or flame, and what is remarkable is always found electrified *negatively*, when at the ſame time the ſurrounding atmoſphere is electrified *poſitively*.

If a perſon *inſpires* common air through a phial of lime-water, the lime-water preſerves its tranſparency, but if he *expires* air into the water, it ſoon becomes turbid, and a precipitation enſues —an evident proof of the preſence of carbonic air in the fluid exhaled from the lungs.

16. Since air is ſo neceſſary to life (13, 14.), and ſince it undergoes ſuch a remarkable change

in the lungs (15.), it will be neceſſary in the next place to inquire how this change is produced.

The ſtructure of the lungs is already too well known to need a particular deſcription, ſuffice it therefore briefly to obſerve, that the innumerable little veſicles, or air-cells throughout their whole ſubſtance, into which the air alternately paſſes, and repaſſes at each reſpiration, are divided from the blood-veſſels only by an extremely thin tranſparent membrane.

Nature, for ſome wiſe purpoſe, has ordained that all the blood in the body muſt paſs through the lungs before it can complete its circuit. As the current of blood is made to paſs in review, as it were, of the air through all the branches of the pulmonary artery, and back again through all the ramifications of the correſponding vein, it ſeems obvious that by being brought ſo nearly in contact, and that through ſuch a vaſt extent of ſurface, they were deſtined to exert ſome important influence on each other.

17. The blood, in its paſſage from the left cavity of the heart through the arterial ſyſtem, is of a florid crimſon colour inclining to ſcarlet, but on its return by the veins, it gradually deepens to a darker red. In its paſſage through the lungs, however, it again recovers its florid colour, and when arrived at the place from whence it ſet out, appears of the ſame bright hue as before.

But if the action of the lungs is by any means ſuſpended 5 or 6 minutes, ſo as to exclude the air, the blood grows ſtill darker, inclining to black. As the colour deepens, the motion of the left cavity of the heart grows gradually weaker, and ſoon ceaſes—that of the right cavity continuing though very ſlowly, and feebly to beat ſome time longer.

The circulation being ſuppreſſed, the brain no longer receives its wonted current of blood which enabled it to diffuſe motion, vigour, and ſenſibility over the whole frame. The animal of courſe ſinks into a torpid ſtate, becomes cold, and apparently dead. If at this period, the lungs in due time are inflated with air, in imitation of natural reſpiration, the dark coloured blood begins to reſume its florid hue, the heart to renew its motion, weakly indeed at firſt, but by degrees more powerfully, till at length the brain recovers its functions, and life is completely reſtored. But if the artificial reſpiration is ſuſpended too ſoon, the blood again loſes its florid colour, the heart ceaſes to contract, and the animal relapſes into its former ſtate of inſenſibility.

If this dark coloured blood be now drawn from a vein, into a phial of either azotic, or carbonic air, it undergoes no viſible change of colour, but if it be received into a phial of Vital air, it ſoon reſumes its florid hue, ſimilar to that which it exhibits in paſſing through the lungs. Or if the lungs of a drowned animal are inflated with Vital air, inſtead of common air, it reſtores the vivid colour of the blood much ſooner.

18. From what has been obſerved (15—17.) it appears evident that the blood, and the contiguous air, in their paſſage through the lungs, undergo a remarkable change by their mutual action upon each other. Nor is this to be wondered at, ſince it has been found by experiment, that Vital air is capable of changing black blood to a bright red, even through the denſe coats of a bladder.

But the change of colour implies a change in the quality of the blood, either from ſomething noxious being expelled from the general maſs, or from ſomething ſalutary imbibed.

That the air which is expelled from the lungs is noxious to animal life, and the air drawn in ſalutary, has been already demonſtrated (14—16.) On weighing the circumſtances (13—17.) it ſeems reaſonable to conclude that the principal uſe of reſpiration, is to carry off noxious air, and to inhale pure air, and that this proceſs is performed by chemical attraction. For the lungs are known to be merely a paſſive organ, being acted upon, and ſupplying the place, (if we may be allowed the homely expreſſion) of a pair of bellows.

The blood, in its rapid career from the heart to all the remote parts of the ſyſtem, verges towards putreſcency, and unavoidably contracts a certain degree of impurity, conſtituting what modern chemiſts ſtyle *carbon* or the baſis of fixed air, which it carries with it to the lungs as its deſtined outlet. Here the impure matter or carbon meets with Vital air, to which it has a ſtronger chemical attraction than to blood; it therefore quits the latter, to unite with the former, and is expelled in form of fixed air. As all the blood muſt circulate through the lungs, each portion, as it paſſes through that organ, muſt undergo the neceſſary purification at each ſucceſſive breathing: and thus the whole maſs alternately contracts impurities, and is alternately purified. This explains why the blood appears bright in the arteries, and dark in the veins; alſo why the Vital air after it has been reſpired diſappears, and why the fixed air* is increaſed (15, 16.).

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* Though the azotic air remains the ſame, yet the Vital air has been diſcovered, at a ſingle reſpiration, to be diminiſhed two thirds, while the carbonic air has been increaſed to 6 times its former quantity. But the volume of air expired never equals that which is inſpired by about 1 fiftieth part. Therefore a conſiderable portion of the air taken in, muſt be retained in the ſyſtem. Beſides it has lately been diſcovered, that Vital air is capable of being abſorbed as well as perſpired by the inviſible ducts of the ſkin.

SECT. VIII.

Of Animal Heat—*Its Source—Uniformity——and Connection with Reſpiration.*

19. It ſeems now to be ſufficiently underſtood, that Heat or, as ſome term it, *calorique* is no longer to be conſidered as a mere quality, dependent on a ſuppoſed vibratory motion in the particles of matter, but as a real principle or ſubtile elaſtic fluid, diffuſed through all bodies in the terraqueous globe; and which becomes manifeſt to our ſenſes, by exciting in us the idea of warmth, and by raiſing the mercury in the thermometer. Before we proceed, therefore, it will be requiſite to inquire into the general properties of heat.

1st. Heat is ſubject to the laws of chemical attraction. When it unites with other bodies, it loſes its own diſtinguiſhing qualities; no longer affects the thermometer, but becomes fixed, and is then termed *latent* heat. Thus the vitriolic acid, and ſpirit of wine, though of no greater heat while ſeparate than the outward air, yet no ſooner are they mixed than they produce a degree of heat equal to that of boiling water. Here the bond of attraction being diſſolved, the latent heat contained in theſe fluids is ſuddenly ſet at liberty, and becomes *ſenſible* heat.

2ly. Heat attaches itſelf to all bodies, partly in a ſenſible, and partly in a latent ſtate; and the whole quantity contained in ſuch body is called its *abſolute* heat.

3ly. Heat leſſens the coheſion, and increaſes the expanſion of bodies. It raiſes thoſe that are volatile, calcines or vitrifies thoſe that are fixed, diſſolves the moſt refractory metals, and finally preſerves that degree of fluidity in bodies, which is eſſential to animal and vegetable life.

4ly. Heat, in its ſenſible ſtate, diffuſes itſelf equally to all ſurrounding bodies that contain leſs of this principle, till it brings them to an equal degree of temperature.

5ly. Heat however is conducted more powerfully by ſome bodies than by others, and this generally in proportion to their denſity. Thus metals are ſuperior conductors to ſtones, ſtones to chalk, &c. When we ſpeak of warm clothing, it is not as we are apt haſtily to conclude, that a garment of ſilk, or flannel, communicates more warmth to the body than cotton, or linen, but becauſe the former being more imperfect conductors, convey leſs heat from the body, and conſequently afford a ſenſation of more warmth.

6ly. Though cold is allowed to produce effects diametrically oppoſite to thoſe of heat, yet it is not, as is commonly imagined, an oppoſite principle, but a mere negative quality, cold being nothing

thing more than an abſence or diminution of ſenſible heat, juſt as darkneſs is of light. The coldeſt bodies in nature, as ſnow or ice, contain a quantity of latent heat, ſufficient when evolved in its ſenſible form, to diſſolve iron or the hardeſt metals.

Were ſenſible heat wholly withdrawn from our globe, an univerſal torpor would ſoon overſpread its frozen ſurface, and the earth with its ſurrounding ocean would ſpeedily be reduced to a huge ball of ice! on the other hand, were all the latent heat ſuddenly let looſe in a ſenſible form, the earth with all its inhabitants would ſoon be burnt up, and the more ſolid parts of the globe, calcined, or even vitrified!

But the AUTHOR OF NATURE has wiſely diſpenſed the principle of heat, though not equally through our planet, yet in ſuch a degree, and under ſuch limitations as was beſt adapted to the well-being of the whole. So admirably tempered is the human frame againſt either extreme, that no climate hitherto diſcovered can be pronounced too hot, or too cold for its native inhabitants.

Having thus far conſidered the general properties of heat (19), we proceed to inquire into its effects on the animal ſyſtem.

20. The heat of inanimate bodies is governed by the temperature of the air, and of ſurrounding ſubſtances, as has already been obſerved (19);

whence is it then that the heat of animals affords ſuch a ſtriking exception to this general rule? why for inſtance, does the human body, during health, preſerve ſuch an uniform degree of temperature, in infancy, and old age—under every variation of ſeaſon, and of climate from the Equator to the Poles? Whence is it that, under theſe extremes where men complain of exceſſive heat, or intolerable cold, (of both which their ſenſations afford very inadequate judgment), the mercury in Fahrenheit's thermometer, when placed under the tongue, or in the cavity of the arm-pit, uniformly points to the 97th degree? This ſurpriſing regularity of temperature, peculiar to the living body, cannot be explained on the principle of circulation, attrition, fermentation, putrefaction, or any other law of the ſyſtem hitherto diſcovered, it muſt therefore be conſidered as, an attribute of vitality, and eſſential to the animal œconomy.

It appears from ſome late experiments, that the natural heat of the body may be ſuddenly diminiſhed, upwards of 16 degrees, by ſitting half an hour in a cold bath, and expoſing the body immediately after it to a cold eaſterly wind. To overcome this ſevere degree of cold, and reſtore the equilibrium, the reaction of the ſyſtem is inſtantly excited, cauſing violent rigors, and other painful feelings, the efforts of nature to preſerve life.*

In caſes of ſhipwreck, or apparent death from drowning, the heat is ſometimes undoubtedly reduced, ſtill much lower without proving fatal.

Fiſhes are nearly as cold as the medium in which they move. Water, of a temperature equal to that in which land animals live, would ſcald them to death. The human body is many degrees warmer than the ſurrounding air, except in thoſe ſultry regions of the Torrid Zone, where the heat of the climate often exceeds that of the blood.

To counteract the effects of intenſe heat, and to enable the ſyſtem to ſuſtain the ſcorching rays of a vertical ſun, Nature excites a copious perſpiration from the lungs, and whole ſurface of the body, the evaporation of which generates a proportionate degree of cold, and preſerves the balance. Hence may be explained, why in the noted experiment of a room heated to 212°, the air of which conſequently equalled that of boiling water, Dr. Fordyce, and others, during a profuſe perſpiration, were enabled to continue ſeveral minutes without undergoing any material increaſe of their natural heat perceptible by the thermometer. Alſo, why in ardent fevers the heat of the body is ſometimes increaſed 9 or 10 degrees, attended with extreme danger till a critical perſpiration ſupervenes, and opportunely aſſuages the exceſs of febrile heat.

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* Phil. Trans. Vol. 82, Art. 10.

The canine race, being deſtitute of cuticular perſpiration, are taught by inſtinct to ſupply the deficiency, by increaſing a ſimilar diſcharge from the lungs. Hence the dog, when overheated, is conſtantly obſerved to expand his jaws, and thruſt out his tongue, in order to increaſe the evaporating ſurface.

The ſudden diminution of heat produced by perſpiration admits of an eaſy ſolution. The fluid, which exhales from the body, conſiſts chiefly of watery moiſture, which uniting with a large portion of ſenſible heat, is carried off in form of ſteam. Hence the more ſpeedy the evaporation, the more ſudden is the diminution of heat; or, in more familiar terms, the greater is the degree of cold thus generated. Hence, by promoting a ſudden evaporation, water may be ſpeedily congealed into ice, even in the hotteſt climate.

This curious phenomenon may be readily exhibited thus. Let a very thin phial, containing a ſmall quantity of water uncorked, be kept wetted on the outſide with a feather repeatedly dipt in Æther (a fluid which evaporates more quickly than any other yet diſcovered), the water in the phial, as ſoon as its temperature is reduced to the freezing point, will begin to congeal and ſoon preſent a cake of ice, to the aſtoniſhment of thoſe natives who never before beheld water in a ſolid form.

21. The blood is the ſource from which the body derives its heat, but as it is conſtantly loſing a portion of the latter, in its circuit to the remote parts, there muſt be a generating power in the ſyſtem, conſtantly operating to ſupply the loſs. To determine wherein this conſiſts, it will be neceſſary in the next place, to trace the connection between animal heat and reſpiration.

It has been ſhewn that, without vital air, neither life nor flame can ſubſiſt (13, 14). But the vital part of the air we breathe is alſo known to abound with heat in a latent form, (a circumſtance perhaps eſſential to permanently elaſtic fluids) and alſo to change the colour of the blood in its paſſage through the lungs to a more florid hue (16, 17). As no elaſtic air, however, is diſcoverable in the blood, the vital air, conſiſting of *Oxygen*, and latent heat, appears to undergo a decompoſition in the proceſs of reſpiration, and by that means not only finds entrance into the blood, but alſo gives it a phoſphoreſcent quality.

For the *Oxygen*, uniting with the blood, communicates the florid colour and poignancy, and at the ſame inſtant depoſits its latent heat, which being gradually evolved in its ſenſible form, pervades the denſeſt parts of the body, diffuſing warmth over the whole frame.

Hence during this *Oxygenation* of the blood, and *production* of animal heat, a double elective attraction ſeems evidently to take place; the blood in the lungs alternately diſcharging the *carbon*, and abſorbing the *Oxygen*, while in its progreſs through the reſt of the ſyſtem, it imbibes the *carbon*, and ſets the latent heat at liberty.

By this curious and truly wonderful proceſs, does animal heat appear to be generated and diſperſed over the ſyſtem according to the demand! By which the human body is enabled to preſerve an equable temperature through all the viciſſitudes of heat and cold to which it is occaſionally expoſed. Independent of reſpiration, however, other cauſes may exiſt in the ſyſtem, that may contribute to the evolution of heat; otherwiſe whence the warm bluſh of baſhfulneſs, or of conſcious ſhame? Whence the increaſe of temperature accompanying every new combination of the fluids, ſo obſervable in glandular ſecretion, inflammation, ſuppuration, digeſtion, &c?

SECT. IX.

Of the PROXIMATE CAUSE *of Death, in Caſes of Drowning and Suffocation.*

22. From what has been obſerved, it ſeems evident, that whether death is brought on by ſubmerſion, ſtrangulation, or noxious air, the viſible effects produced on the vital organs are ſo nearly ſimilar (1 to 6), that theſe ſeveral modes of ſuffocation may perhaps all not improperly be referred to one common cauſe.

The ableſt authors, hitherto have been greatly divided in their opinion, not only concerning the nature of vital action, but the cauſe of its ſuſpenſion. By ſome, apparent death is pronounced to be an affection of the lungs; by others, of the heart; while others again contend that it is wholly ſeated in the head. Some attribute it to a diſtention of the brain; others to a collapſe—An evident proof that the proximate cauſe has not yet been fully diſcovered. Such a ſtriking difference in Theory cannot but materially influence Practice, and therefore demands inveſtigation.

In caſes of drowning, M. Louis, De Haen, and others conſider the introduction of water into the wind-pipe as the immediate cauſe of death. But later experiments have ſhewn, that 2 ounces of water—a quantity, perhaps, greater than is commonly found in the lungs of drowned animals, may be injected into the wind-pipe without proving fatal.

In the *Hydro-thorax*, an incredible quantity of water is ſometimes collected in the cavity of the cheſt, without ſuddenly deſtroying life. A remarkable inſtance of this is related in the Memoirs of the Pariſian Academy of Chirurgery, where upwards of 5 pints were repeatedly drawn off by a perforation made between the ribs. As the inſtrument could be paſſed to the depth of 5 inches into the cavity, without touching the lungs, that organ muſt have been almoſt deluged with water previous to each operation, and yet the fluid, notwithſtanding its preſſure, did not produce a ſudden ſuſpenſion of the vital functions.*

If an artificial dropſy of the cheſt be produced by injecting, a conſiderable quantity of water into the thorax of a healthy animal, it immediately cauſes oppreſſion, and difficulty of breathing but no fatal ſyncope enſues. For the water is gradually abſorbed, and the ſymptoms ſoon diſappear. In drowning, the caſe is very different, ſince a few minutes ſubmerſion is ſufficient to deſtroy the life of the animal, even whether water enters the wind-pipe, or not, for in many caſes none is to be found in the lungs after death. But if the ſmall portion of water which occaſionally enters the lungs (as ſometimes actually happens), be ſtill inſufficient to cauſe death *directly* by ſuſpending reſpiration, it follows that, it muſt produce it *indirectly* by excluding the atmoſpheric air.

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* Memoirs de l' Acad. de Chirurg. Tom. 2. p. 546.

23. Other eminent writers have endeavoured to explain the death of drowned, or ſuffocated animals, from a ſurcharge of blood in the veſſels of the brain, and have therefore conſidered it as a caſe of real apoplexy. Among theſe may be mentioned M. Littre, Wepfer, Boerhaave, and Cullen, to whom alſo may be added the ingenious Mr. Kite, who, (in his late elaborate eſſay) appears to have inveſtigated the ſubject with no ſmall attention. An opinion advanced by ſuch able writers, and ſo powerfully ſupported by their followers ought not to paſs unnoticed.

The diſtention of the blood-veſſels of the brain obſervable in theſe caſes, and particularly after ſtrangulation (though much inſiſted upon), affords no convincing proof of apoplexy, ſince a variety of other inſtances of violent death preſent ſimilar appearances, even where there could be no ſuſpicion of the brain being overcharged.

In almoſt every fatal accident proceeding from an *external* cauſe, the blood preſerves its fluidity much longer than where ſudden death is occaſioned by any internal affection; and the elaſtic force of the arteries continues ſeveral hours after death to propel the uncoagulated blood onwards towards the veins. Hence blood often flows a freſh from the orifice of a vein long after life is extinct. Hence alſo the apparent diſtention of the veins without any real increaſe of the quantity of blood. Nor is it even pretended that in violent death, produced by drowning or ſuffocation any extravaſation of blood, or ſerum, has ever yet been diſcovered in the cavities of the brain, though generally very conſpicuous in fatal incidents occaſioned by genuine apoplexy.

Mr. Kite, one of the moſt powerful advocates on the ſide of apoplexy, having endeavoured to prove, that in caſes of hanging, death is not occaſioned by the compreſſion of the nerves of the neck, or of the carotid arteries, adds the following remarkable paſſage, which unfortunately ſtrikes at the very foundation of that ſyſtem of *plethora* which hitherto he had ſo ſtrenuouſly ſupported:

" A third opinion is, that death proceeds from the compreſſion of the jugular veins: but it appears from the experiments of M. Emettus that all the larger veins of the neck, both *internal* and *external* have been ſeparately tied, without apoplexy, or even ſleepineſs having been induced. Further it is related, that the carotid arteries and jugular veins being *all tied* in a dog, that he enjoyed the moſt perfect health and vivacity

city for ſome weeks! The ſame author further obſerves, that upon repeating the operation often, although none of the dogs died, or were apoplectic, yet ſome of them, for the ſpace of a few hours, ſeemed ſleepy." *

Certainly a more likely method of producing a ſudden and violent ſurcharge of blood in the brain could hardly have been deviſed by human ingenuity, and yet we are told ſo far from cauſing apoplexy, it "only occaſioned drowſineſs for a few hours, and that in all other reſpects the animals enjoyed the moſt perfect health and vivacity."

The experiments, moreover, having been *often* repeated, and ſimilar ones alſo inſtituted by Mr. Kite and others with the ſame effect, we can ſcarcely entertain a doubt reſpecting their validity.

Now, admitting theſe facts, the concluſion is obvious, viz. that in caſes even of hanging, death is not occaſioned by a congeſtion of blood in the brain.

Neither, on the other hand, does diminiſhing the quantity of blood conveyed to the brain retard the fatal event, as may be ſeen from the following experiments.

"The wind-pipe of a dog," ſays an acute Experimentaliſt, "was ſecured by a ligature at the inſtant of inſpiration; in leſs than 4 minutes he ceaſed to ſtruggle. The blood in the left ſide of the heart compared to that of the right was as 13 to 12. The veins of the head were evidently leſs diſtended than natural. Here then, there being no obſtruction to the paſſage of the blood through the lungs, it could not be collected in the right ſide of the heart, and conſequently *no* accumulation was found in the head, and yet this animal died as ſoon as others, from ordinary hanging."

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* Kite's Eſſay on the recovery of the apparently, dead. p. 139.

Again—"The 2 carotids of a dog were ſecured (which we now know may be done without materially injuring the functions of the animal). In half an hour after this operation, he was hanged. In leſs than 4 minutes he ceaſed to move. The veſſels of the brain were much leſs diſtended than in ordinary death. Here the principal ſupply being cut off, inſtead of the veſſels of the brain being in a ſtate of congeſtion, contained a much *leſs* quantity than natural, and conſequently no ſpecies of apoplexy could follow from *diſtention*, and yet this animal died as ſoon as others which had undergone no ſuch operation." *

The following experiment, by that eminent anatomiſt Profeſſor Monro, evidently proves that, in hanging, death is not produced by apoplexy, but a very different cauſe.

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* **Coleman's Diſſertation on ſuſpended Reſpiration. p. 137—139.**

"A dog was ſuſpended by the neck with a cord; an opening having been previouſly made in the wind-pipe below the cord, ſo as to admit air into the lungs. In this ſtate, he was allowed to hang 3 quarters of an hour, during which time, the circulation and breathing went on without being much interrupted by the experiment. The cord being now ſhifted *below* the opening into the wind-pipe, ſo as to intercept the ingreſs of air into the lungs, and the animal being again ſuſpended, was completely dead in a few minutes." Then which nothing can be more deciſive, at leaſt ſo far as one ſolitary experiment can extend.

It is moreover obſervable that in apoplexy, life often continues ſeveral hours, while in drowning or hanging, the animal functions are aboliſhed in a few minutes. In apoplexy, reſpiration, together with the action of the heart and arteries, go on, and the pulſe often vibrates more forcibly than in health. In hanging, or drowning, reſpiration is ſuppreſſed, and the pulſe obliterated.

In apparent death from apoplexy, very few recover, and thoſe few generally become paralytic.

In vital ſuſpenſion from drowning or hanging, many are reſtored, and yet no palſy ſupervenes.

In the former, copious bleeding affords the principal relief; in the latter, it generally proves highly injurious.

In a word, the two caſes evidently appear to be totally different, and to require a very different mode of treatment.

In caſes of apparent death, an apoplexy indeed may ſometimes occur, not as a *certain* conſequence but as an *accidental* circumſtance. Thus in hanging, if the feet are pulled violently to accelerate death, as often happens, it may produce a diſlocation of the vertebræ of the neck, and extravaſation in the brain. Or in drowning, if the perſon happens to be in a deep ſtate of intoxication, or receives a contuſion of the head in falling into the water, and yet after all is reſtored to life, it is no wonder if an apoplexy, or palſy enſues—a circumſtance, however, by no means frequent in other caſes of reſtoration from apparent death.

24. Others imagine they have traced the *immediate* cauſe of death, to the *preſence* of *black blood* in the left ſide of the heart, and its vicinity. This blood being deprived of the influence of the air, is ſuppoſed to be now rendered incapable of exciting the action of the heart, and therefore muſt be the *proximate* cauſe of the ſuſpenſion of its functions.*

This opinion, though ſufficiently plauſible like the former, may poſſibly, on further inquiry, be found equally deſtitute of foundation. For in the firſt place, this dark coloured blood is by no means peculiar to caſes of drowning or ſuffocation, being on the contrary almoſt an inſeparable attendant on ſudden death, from whatever cauſe produced.

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* Godwin on the Connection of life with reſpiration, p. 195

2ly. Even admitting it to be the *immediate* cauſe of death, in the caſes now under diſcuſſion, it follows that if by any means we could reſtore this black blood to its florid colour, we might with certainty reſtore life. For the cauſe being removed, the effect muſt ceaſe. Now this change of colour may be readily accompliſhed in the pulmonary blood by merely inflating the lungs with common air. And were this alone ſufficient to recal life, would it not be unpardonable to ſuffer any one to die ſuddenly of this dark coloured blood, where a bent tube, and a pair of bellows could be procured? But experience ſhews that inflating the lungs of an animal apparently dead, though it changes the contiguous blood to a florid ſtate, yet unleſs it alſo ſucceeds in reſtoring the natural action of the heart and lungs, it avails nothing towards the reſtoration of life.

3ly. It further appears from experiments on drowned animals, that the heart inſtead of inſtantly ſtopping, continues to contract a conſiderable time after the blood has acquired this dark colour. In fiſhes, and in the human embryo, the blood muſt neceſſarily appear dark, and yet the circulation is performed with ſufficient vigour.

4ly. In ſuſpended reſpiration, the dark coloured blood is not confined to the cavities of the heart and pulmonary veſſels, but extends through the circumvolutions of the brain, and whole ſanguiferous ſyſtem. Therefore if the action of the heart could not be excited, until the entire maſs of blood were changed to its priſtine colour, no perſon apparently dead could ever be reſtored. For were black blood the efficient cauſe of the ſuſpenſion of the action of the heart, that organ would for ever remain at reſt, till the neceſſary change of colour could be brought about.

5ly. It has been obſerved by an eminent author, that on expoſing an animal to intenſe heat, the blood when drawn from a vein appeared as florid as that which iſſued from an artery. That, on the contrary, when ſubjected to extreme cold, the blood aſſumed as dark a colour as if the animal had been drowned, and yet theſe remarkable changes in the appearance of the blood, cauſed no viſible change in the animal functions.

Can we ſuppoſe, then, that dark coloured blood ſupports life in one caſe, and deſtroys it in another?

In the cold fit of a quartan ague, the lips and whole viſage ſuddenly aſſume a livid hue. In the ſubſequent hot fit, the countenance becomes intenſely red. But notwithſtanding the blood ſuddenly becomes dark coloured, during the ſeverity of the rigor, yet the vital actions are not ſuſpended; on the contrary, the pulſe and reſpiration are manifeſtly accelerated, and though the patient ſhivers with extreme cold, the thermometer placed under the arm-pit ſhews no real diminution of natural heat—A circumſtance, which I have more than once obſerved, but not without aſtoniſhment!

6ly. During ſuſpended reſpiration, the black blood in the left cavity of the heart and arterial ſyſtem cannot reſume its florid colour, till it has completed its circuit, and returned through the lungs. Hence it is evident, the heart muſt be brought to contract from the ſtimulus of this black blood, before the circulation can be reſtored.

On the whole then, ſince the preſence of black blood has been found to be neither incompatible with life, nor to preclude recovery; it cannot be admitted as the *efficient* cauſe of the ſuſpenſion of the circulation, much leſs as the *immediate* cauſe of death; but the effect, or rather a concomitant circumſtance.

25. "The *proximate cauſe* of that diſeaſe produced by drowning, hanging, and ſuffocation," ſays another late writer, "appears to be mechanical obſtruction in the interior pulmonary veſſels, from *collapſe* of the lungs, with a want of latent heat in the blood."*

This idea ſeems to approximate more nearly to the truth, but ſtill leaving a ſmall ſpace between, reſembles thoſe parallel mathematical lines, which are ſaid to be continually approaching each other, and yet never meet. For his own experiment, ſo well imagined for guarding againſt accumulation in the brain, muſt have ſtill more directly prevented collapſe, or mechanical obſtruction in the interior pulmonary veſſels. Therefore though meant to ſubvert the hypotheſis of another, it unluckily tends to ſap the foundation of his own.

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* Coleman's Diſſertation on ſuſpended Reſpiration. p. 150.

Accordingly it informs us "there being *no* obſtruction to the paſſage of the blood *through the lungs*, it could not be collected in the right ſide of the heart, and yet this animal died as ſoon as other animals from ordinary hanging." *

Beſides, were this the real cauſe of apparent death, it is not eaſy to conceive how reſtoration could ever be brought about without inflating the lungs; and yet inſtances of ſpontaneous recoveries are by no means wanting.

In certain caſes, moreover, the heat of the body, even after death, has been found to exceed that of health, and therefore neither a *want of latent* or *ſenſible* heat in the blood, could be ſuppoſed to conſtitute any part of the diſeaſe. Thus a violent flaſh of lightning, the fumes of charcoal or of burning ſulphur cauſe immediate death or ſuffocation, without extinguiſhing animal heat, which rather increaſes, and continues ſeveral hours.

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* Diſſertation on ſuſpended Reſpiration. p. 138.

The lungs, after the laſt expiration, contain a quantity of air, and inſtead of ſuffering a *collapſe*, are often found conſiderably *diſtended* after death. The ſame is obſerved in animals that die under the exhauſted receiver of an air-pump, which probably happens in the act of inſpiration. Be this as it may, a collapſed ſtate of the lungs, upon which ſuch ſtreſs has been laid, ſhould it ever occur, cannot be the immediate cauſe of death, but rather the effect of a certain mode of dying.

26. Others imagine the queſtion admits of a very ſimple and eaſy ſolution, and therefore without heſitation pronounce the proximate cauſe of death (in the caſes under conſideration) to be nothing more than a mere *ſtoppage of reſpiration*. But they ſeem to forget that the effect ought immediately to follow the cauſe, as the ſhadow does the ſubſtance. Were their poſition true, perſons in a ſtate of ſyncope or apparent death would be utterly irrecoverable, and torpid animals could never be rouſed into action. Not to mention that in the Pearl Fiſheries expert divers are known to remain 12 or 14 minutes under water without breathing.

27. It appears from what has been obſerved, that the effects of the various kinds of ſuffocation are ſo

very ſimilar, that they may be conſidered as dependent on the ſame cauſe, viz. the privation of vital air (22). This animating fluid, derived from the atmoſphere, being proved eſſential to reſpiration (13, 14), and reſpiration to life (19), leads us to trace the following chain of cauſes and effects, which in the act of drowning or ſuffocation of neceſſity follow each other in rapid ſucceſſion.

No ſooner is the vital air excluded, than reſpiration is ſuſpended; reſpiration being ſuſpended, the paſſage of the blood through the lungs is intercepted, and of courſe through the whole ſyſtem. The action of the heart being impeded by the ſame cauſe, the circulation is ſuppreſſed. The brain, unſupported by the circulation, being unable to exert its influence, the mental and corporeal actions ceaſe, and the mind is no longer conſcious of the ſtate of the body. The blood being deprived of its power of generating heat, a coldneſs diffuſes itſelf over the ſyſtem. Unleſs aid be now properly adminiſtered, the principle of irritability gradually forſakes the fibres, firſt in the extreme parts, afterwards in the heart itſelf, when the animal dies.

28. From an attentive conſideration of the various phenomena thus brought into a ſmall compaſs, the order in which they ſucceed one another, and the effects which enſue (27); does it not appear evident that, in theſe different ſpecies of ſuffocation,

the EXCLUSION of VITAL AIR from the lungs is the primary cauſe of ſuſpended reſpiration, and that ſuſpended reſpiration is the immediate cauſe of the ſuſpenſion of the other vital actions? But ſince vital action may be ſuſpended by various cauſes without being extinguiſhed, it is now well known that perſons, labouring under ſuch a ſtate of ſuſpenſion, may often yet be recovered by renewing the action. Such a critical ſituation, however, may not improperly be conſidered as an intermediate ſtep between life and death. If to this ſucceeds the EXTINCTION of IRRITABILITY, or of that oſcillatory principle (whatever it may be) which renders the heart and muſcular fibres SUSCEPTIBLE OF STIMULUS, it conſtitutes the PROXIMATE CAUSE OF DEATH.

This law of Nature, which extends to every living creature, is immutably fixed by the CREATOR, otherwiſe Man might preſumptuouſly arrogate to himſelf the power of raiſing the dead, and diſpenſing even immortality.

29. It were therefore to be wiſhed, that the terms *re-animation*, *re-ſuſcitation*, *re-vivification*, &c. which are now become ſo familiar, but which to ſuperficial readers may ſeem ſtrongly to imply the act of *reſurrection*, were either laid aſide, or explained under due reſtriction. To reſtore a perſon from a temporary ſuſpenſion of vital action, is within the

province of the Phyſician: But to reſtore life, after it has entirely vaniſhed, is an act of OMNIPOTENCE, and belongs ONLY to HIM, who gave it. The former is merely to re-kindle the flame of a taper, by gently fanning the ignited wick: the latter, to re-animate a corpſe, after the vital ſpark is totally extinct.

As abſolute death conſiſts in a total ceſſation of all the vital and animal functions, with an entire loſs of irritability; ſo apparent death, in the various kinds of ſuffocation commonly termed *aſphyxia*, may be defined A TEMPORARY SUSPENSION OF THE VITAL MOTIONS, IN CONSEQUENCE OF THE PRIVATION OF VITAL AIR ESSENTIALLY NECESSARY TO RESPIRATION.

If this idea of the nature of the diſeaſe be juſt, it will enable us to unfold the principal ſymptoms, and to point out the moſt rational method of cure.

30. From the effects of vital air, in ſupporting reſpiration; in giving a florid colour to the blood; and in generating heat (13—19); we learn why in ſuſpended reſpiration, the lungs ceaſe to expand, the heart to contract, the arteries to vibrate, and finally why the machine, though ſound and entire in all its parts, yet, on a ſudden, like a clock whoſe pendulum is ſtopped, remains entirely at reſt. In the latter, if we move but the pendulum, the wheels are immediately put in motion, and the clock

again correctly marks its hours and minutes as before: ſo likewiſe in the animal machine, (for ſuch is the harmonious conſent of parts) that if motion can but be renewed in one of the principal organs, it is directly communicated to the next, and from thence, to all the reſt.

Thus if the lungs reſpire, the heart recovers its action, the brain its energy, the nerves their ſenſibility: the grand obſtacle once removed, the ſubordinate ſprings of life preſently reſume their reſpective movements.

From the privation of vital air in drowning, we can now explain why the blood grows dark, the lips and countenance livid, and why the body loſes its native heat; ſince, by renewing reſpiration, circulation is renewed, and the blood, having regained what it had lately loſt, all theſe ſymptoms ſoon diſappear. But ſuch is the importance of vital air to organic life, that its effects deſerve yet further inveſtigation.

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SECT. X.

VITAL AIR—*Its extenſive Influence in the Animal Œconomy—Whether the Source of Irritability, in all organized bodies.*

30. Though Vital air appears to have been firſt diſcovered by the ſagacious Dr. Mayow, about the middle of laſt century; and though he deſcribed ſome of its moſt curious properties, yet the ſubject was unaccountably ſuffered to paſs into oblivion, till lately that it was fortunately revived by Dr. Prieſtley and others. From their obſervations, reſpecting its effects on the blood and reſpiration, I was led to conſider it as the CAUSE of irritability, the PRINCIPAL AGENT in the animal œconomy, and therefore ventured, at an early period, to throw out ſome HINTS towards expediting its application to medicine, and more particularly to the theory of Animation. The idea at length, being adopted by others, has of late been offered as entirely *new!* Be this as it may, ſince Vital air has been proſecuted with ſuch uncommon ardor, it has given birth to ſome of the moſt brilliant diſcoveries which ſhed luſtre on the preſent æra. From which, we are now enabled, not only to unfold the theory of reſpiration and animal heat,

but alſo to explain many other curious phenomena both in health and diſeaſe. Among theſe, the following problems, which, many years ago, I propoſed under the form of queries, appeared to me to reſt wholly on the properties of vital air.* Whether even at the preſent advanced period of ſcience, they will admit of a more ſatisfactory ſolution on any other principle, is ſubmitted to the diſcerning Reader.

1st. Why the new-born infant, by unerring inſtinct, is taught to breathe within a few minutes after its birth, otherwiſe it dies. And why, having once drawn in the vital air, it is ever after under a neceſſity of continuing that proceſs to the laſt moment of life.

2ly. Why the ſubtile fluid acquired by the lungs is perpetually conſuming by vital action, and demands perpetual renovation from the external atmoſphere.

3ly. Why the lungs may be conſidered as a pneumatic engine, with which the blood requires to be inceſſantly fanned: and why, if this operation be ſuppreſſed only a few minutes, the animating principle, like an expiring taper, fades, languiſhes, and becomes extinct.

4ly. Why an animal, after its wind-pipe is divided,

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* Hints on Animation, p. 122.—Printed for Dodſley, 1783.

vided, and the contents of the cheſt laid open to view, may be kept alive ſeveral hours by inflating the lungs with air. And why the appearance of alternately living and dying may be thus exhibited during the interval, by repeating and occaſionally ſuſpending the operation. Alſo, Why, in caſes of drowning and ſuffocation, inflating the lungs with pure air is of the firſt importance in reſtoring animation.

5^{ly}. As the purity of the atmoſphere, the florid colour of the blood, and the vigour of the ſyſtem depend chiefly on vital air; and ſince vital air is moreover the baſis of one of the moſt ſtriking primary colours, viz. red—in all its beautiful tints—we may eaſily explain the following circumſtances.

Why, in ſudden faintings, the ſpeedy removal of the patient into the open air affords ſuch immediate relief.

Why an open country or ſequeſtered village is more ſalubrious than a large town or populous city.

Why the inhabitants of the former, who enjoy ventilation, and breathe pure mountain air, appear with lively and ruddy countenances; while thoſe, who reſide in the latter, and reſpire the vitiated air of crowded rooms, look pale and ſickly.

6^{ly}. Why in certain diſeaſes, where reſpiration is extremely laborious, and the blood in conſequence imperfectly oxygenated, as in aſthma and dropſy of the cheſt, the countenance wears a livid aſpect.

7ly. Whether a defect of vital air in the ſyſtem, as in caſes of ſea-ſcurvy and malignant fevers, may not explain why petechiæ or livid ſpots appear on the ſkin.

Alſo, whether the different ſhades from purple to black, which the parts aſſume in the blood-ſhot eye, in contuſion, in mortification, and finally in thoſe purple marks with which children are often born, and though commonly attributed to the longings of the mother, may not more probably proceed from the ſame cauſe, viz. a partial or imperfect oxygenation of the blood.

8ly. Whether it be not an exceſs of vital air, on the contrary, which often heightens the complection to a crimſon or ſcarlet dye, as in the exacerbation of hectic or inflammatory fevers.

9ly. Laſtly, whether this principle, which reddens the blood and tinges the cheek of beauty, is not probably the ſame which diffuſes elegant ſhades of the ſame colour over a conſiderable part of the vegetable creation—which blooms in the roſe, the tulip, and the carnation; which glows in the weſtern ſky; and which adds even colour to the calces of metals, as in red lead, cinnabar of antimony, vermilion, &c. But to return;——

31. It is obſervable, that the motion of the heart not only ſurvives that of the organs of voluntary motion, but continues a conſiderable time

after it is ſeparated from the body. Nay, after it has even ceaſed to palpitate, yet as it ſtill retains a latent power of contraction, its ſyſtole and diaſtole may, by the application of heat and other ſtimuli, be alternately renewed and continued ſome time longer.

Hence it would appear, that in drowning or ſuffocation, though the pulſe be imperceptible, and life apparently extinguiſhed, yet the heart ſtill preſerves this latent power or ſuſceptibility of motion, longer than is commonly imagined; for though unable to propel the blood through the vaſcular ſyſtem, yet it wants only to be gently excited by ſuitable ſtimuli adapted to renew its action, without exhauſting its power. Hence may be underſtood the numerous inſtances of recovery from apparent death by means that, at firſt view, would ſeem wholly inadequate to the effect.

Therefore, though the voluntary motions are governed by the brain, through the intervention of the nerves, the involuntary organs ſeem to be actuated by the irritable principle independent of the brain: or in other words, ſenſibility and irritability, though often confounded, are evidently diſtinct in their nature and in their origin. The former depends wholly on the nerves, the latter is a property peculiar to muſcles. Some parts of the body are very irritable, though but ſlightly ſenſible. The nerves themſelves are acutely ſenſible, but not irritable.

In the firſt rudiments of the chick, at an early period of incubation, and before the brain or nerves are viſible, the *punctum ſaliens* points out the embryo heart in miniature, and marks its primæval irritability as a ſure preſage of vitality. As this ſingular organ thus exhibits irritability the firſt, ſo it never relinquiſhes it till the laſt, and may therefore be conſidered as the *primum movens* and *ultimum moriens* of the animal machine. Could we trace the origin of its motion to its true ſource, we might perhaps be enabled to renew its action with more certainty when accidentally ſuſpended, and throw new light on the theory of animation.

Haller and other anatomiſts agree, that the heart has very few nerves in its internal ſubſtance, but M. Behrends even denies that it has any, except a few ſmall twigs, which wholly terminate in the coronary veſſels. Theſe nerves, adds he, or thoſe of the ſpinal marrow being irritated, diſturb not its motion, neither does the application of opium. In apoplexy, all the functions depending on the nerves are ſuſpended, but not the motion of the heart. That it has very little ſenſibility is evident from this, that when pierced with a ſword, or otherwiſe injured, a ſenſe of faintneſs enſues, but ſcarcely any pain. Probably its action is entirely owing to the ſtimulus of the blood applied to the irritable power. It does not like other muſcles become weary by inceſſant motion, neither does it become leſs irritable to the blood, by the daily repetition of the ſtimulus, any more than the eye does to light, the ear to ſound, the ſtomach to the gaſtric juice, or the inteſtines to bile. Though its irritability remains when the nerves are deſtroyed, yet its action then, cannot be ſo eaſily renewed as that of other muſcles, by means of animal electricity.

If irritability then actuates the heart and vital organs independent of the nerves, it accounts why the involuntary motions which are concerned in circulation, nutrition, ſecretion, digeſtion, the healing of wounds, and regeneration of parts, are carried on as well during ſleep as in our waking hours. This independent action is ingeniouſly explained by the learned Dr. Johnſtone, on the ſuppoſition that the nervous ganglion performs the office of a ſeparate brain or ſenſorium. This principle, when once eſtabliſhed, may lead to future diſcoveries. Every muſcle and, probably, every fibre of a muſcle poſſeſſes a determinate portion of irritability neceſſary to its natural tone. The preſence of a ſtimulus applied to the irritable fibre excites an oſcillatory motion, the reſult of which is vital action.

The blood and animal fluids are the natural ſtimuli, deſtined to ſupport vital action, and at the ſame time to draw off a certain proportionate quantity of irritability. If the natural ſtimuli are deficient, irritability will be increaſed; if too powerful, diminiſhed. Irritability is daily replenished by the lungs, and alternately conſumed by vital action, the ſurplus therefore and no more ought to be carried off by ſtimuli. Hence the irritable fibre is never paſſive, but in a conſtant ſtate of action; and vitality, as has been already hinted, conſiſts in action and reaction between the vital organs and their reſpective ſtimuli.

The periodical motions in organized bodies, the return of the cold and hot fit in agues, and the remiſſions and exacerbations in other acute diſeaſes ſeem to depend on the alternate diminution and accumulation of irritability. On the ſame principle, probably, may be explained the hyſteric and epileptic paroxyſm, and other remarkable phenomena in diſeaſes.

In regulating theſe, and other inordinate motions, by nicely adjuſting the natural and artificial ſtimuli to the exact tone of the irritable fibre, conſiſts the GRAND SECRET in the art of healing. Stimulating medicines are ſaid to excite irritability, ſedatives to depreſs it. How?—Why only by altering the equilibrium. Thus heat and light act as ſtimuli, by drawing off irritability; cold and darkneſs, as ſedatives, becauſe, though only negative qualities, they tend to accumulate it.

Thus wine, ſpirits, opium, and other active remedies are ſtimulants, becauſe applied in a certain moderate degree, they excite irritability; but carried to exceſs, they exhauſt it, and become ſedatives. To this principle perhaps may be referred, the action of ſome of the moſt deadly poiſons, ſuch as the laurel-water and American *Ticunas*, which almoſt inſtantly exhauſt irritability; and the moment irritability is exhauſted, the animal ceaſes to live.

The principle of irritability ſeems ſtronger in the loweſt order of animals than in Man, who far ſurpaſſes every other animal in point of intellect. In proportion as the vital power prevails, the intellectual power is deficient, and irritability is made to compenſate for the want of ſagacity. Thus the Polype, though deſtitute of brain and nerves, and more ſimple in its ſtructure than, perhaps, any other organized being, poſſeſſes a power, which almoſt renders it proof againſt external injury. Even the cutting it into ſundry pieces ſerves only to quicken its faculty of reproduction, for it ſoon regenerates its ſcattered limbs, and multiplies itſelf into ſo many different polypi—A wiſe proviſion of Nature for the preſervation of life, and perpetuation of the ſpecies, even in the meaneſt of her creatures! In ſuperior animals, according to the degree of inſtinct or ſagacity which they poſſeſs of guarding againſt injury, irritability diminiſhes, and *vice verſâ*. Hence in infancy, where the intellectual power is weakeſt, irritability is greateſt; and as the former advances, the latter decreaſes.

As irritability co-exiſts with animal heat, and keeps pace with it through life, it probably proceeds from a ſimilar cauſe. But animal heat has already been ſhewn to depend on vital air, for without vital air no heat can be generated (13—19).* May not vital air then, ſo eſſential to heat, be conſidered as the PROXIMATE CAUSE of IRRITABILITY, agreeably to what I have hinted in a former Eſſay ?—HINTS on Animation. p. 122.

Admitting this, we can better account for the following circumſtances.

1st. Why irritability in a ſtate of excitation may e deemed the principle of life.

2ly. Why irritability is increaſed by breathing pure vital air.

3ly. Why noxious air, by deſtroying irritability, nd depriving the muſcles of vital air, kills an nimal ſooner than other modes of ſuffocation.

4ly. Why the heart, being ſtimulated with blood at has juſt received oxygen in its paſſage through the lungs, poſſeſſes more heat and irritability than any other muſcle in the body.

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* It has lately indeed been alleged by M. Deciman and others, t flame may be excited, without the intervention of vital air, a mixture of ſulphur with filings of copper or any of the or imperfect metals. Alſo that inflammable air contains more *orique* than even vital air; and hence if heat be evolved, matter from what ſubſtance, it ſtill produces the above ect.—True—but the fact muſt be incontrovertibly proved bee we can admit the concluſion.

5ly. Why its right cavity, containing a greater quantity of heat evolved in a ſenſible form, is more irritable than the left, which receives it in a latent ſtate. And, conſequently, why the vital motion of the right ſurvives that of the left.

6ly. Why the calces of metals, in conſequence of the vital air which they imbibe during calcination or ſolution in mineral acids, become far more active medicines than the metals themſelves. Hence the extraordinary power which calcined mercury, corroſive ſublimate, red precipitate, and lunar cauſtic, though applied in very minute quantity, are found to exert on the irritable fibres.

7ly. Finally, Why vital air promiſes to afford the moſt effectual antidote againſt the baleful effects of mephitic vapours, putrid animal effluvia, and other ſpecies of noxious air, which ſuddenly extinguiſh human life.

SECT

SECT. XI.

Phenomena of the Brain and Nerves—Laws of Organic Life, obſervable in the Animal and even Vegetable Œconomy.

32. From the reſult of various experiments, it ſeems evident, that the nerves are the inſtruments of ſenſe and motion, or the conductors of ſome ſubtile agent, by the intervention of which, a reciprocal intercourſe is carried on between the brain, and all the other parts of the nervous ſyſtem.

2ly. That the brain, moreover, is the organ of ſenſation, volition, and all the intellectual faculties; and may therefore be conſidered, as the *ſenſorium* or ſtorehouſe of ideas.

3ly. That the Sentient immaterial principle is ſo intimately connected with the brain and nerves, that motions excited in them give birth to correſpondent ſenſations, and theſe in their turn produce new motions in the organs to which they are tranſmitted.

4ly. That the mechaniſm of the brain, however, is not the immediate cauſe of mental operations, only the inſtrument by which the SENTIENT PRINCIPLE is deſtined to perform its offices through a corporeal organ; and that the nature of this connection, between *mind* and *matter*, is wholly unknown.

5ly. That ſenſation ariſes from the impulſe of bodies on the ſentient extremities of the nerves. That ſenſation produces volition, and volition determines the action of the muſcles.

6ly. That the action of the brain, in performing voluntary motion, is excited by the will, according as this is determined by various appetites and propenſities, and particularly by vehement acts of volition, termed paſſions; without the brain however being conſcious of the motions excited, much leſs of the organs employed. Hence (2—6) the mechaniſm of the brain, unleſs united with a Sentient principle, would be wholly inadequate to its functions (2).

7ly. That the action of the brain is influenced by habit, which aſſociates motions with ſenſations independent of each other, ſo that the renewal of the ſenſation, or even its idea, renews alſo the motion.

8ly. That the ſympathy of parts does not depend on contiguity, or mere connection of nerves, but on the impreſſion being tranſmitted through the brain to the ſympathizing organ.

9ly. That the action of the brain is ſubject to alternate ſtates of reſt and activity, as in ſleep and waking. That, in the former, the animal functions ceaſe, while the vital functions continue.

10ly. That the action of the brain undergoes a ſtill greater degree of ſuſpenſion in the aſphyxia, wherein the vital functions ceaſe, and the circulation is ſuſpended, but may ſtill be revived while the vital organs remain ſuſceptible of ſtimuli (9).

11ly. That the ſenſibility of the ſyſtem depends on the different degrees of excitement of the brain, and of the ſentient extremities of the nerves. That exceſſive excitement occaſions a derangement of the brain, as in phrenſy and inſanity. That a diminution of the natural excitement produces a partial ſuſpenſion of its functions, as in torpor and lethargy.

12ly. That the ſenſibility of the ſyſtem is increaſed by heat, and diminiſhed by cold; and is moreover affected by all thoſe circumſtances which affect irritability (31). Both theſe principles can be excited by ſtimuli applied either to the muſcles themſelves, or to the nerves connected with them. Both can ſubſiſt about the ſame length of time, without any connection with the brain, and alſo in the entire body ſometime after life has apparently ceaſed. Both, however, in the living ſtate, are ſubſervient to the SENTIENT PRINCIPLE (1—2).

13ly. The effects in both caſes being ſo ſimilar, (32), ſome phyſiologiſts have been led to conclude that the conſtituent matter of the nerves, and muſcular fibres is alſo ſimilar, viz. a continuation of the medullary ſubſtance of the brain. And that the contractile power of the latter, not found in the former, may depend on peculiar arrangement, or organization, and yet the active principle or moving power be ſtill the ſame in both.

Though this opinion has been adopted and ably ſupported by that eminent philoſopher Dr. Cullen, yet it ſeems liable to ſome weighty objections, ſince we know that the vegetable tribes though deſtitute of brain and nerves, are yet endowed with irritability, (and as ſome imagine) a perceptive faculty; otherwiſe it may be demanded whence proceeds the apparent paſſion of love, which viſibly actuates theſe vegetating amourets at the ſeaſon of impregnation, as beautifully illuſtrated by the ingenious Dr. Darwin?* Why are they ſuſceptible of the ſtimulus of heat and light? Why do they alternately ſleep and wake at ſtated hours, and invariably turn towards the ſun? Why, if confined in a dark room, do they languiſh, and ſearch for any crevice, as it were, to eſcape, and to expand their foliage to the ſolar rays? Why do the voluntary motions of the moving plant continue during the preſence of day, and regularly ceaſe on the ſun's departure? Why does the ſenſative plant ſhrink from the ſlighteſt touch, and droop its leaves according to the degree of ſtimulus? Why does the Dionæa Muſcipula, when irritated by intruding inſects, firſt entrap them, and then deliberately ſqueeze them to death?

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* See his elegant deſcription of the LOVES of the PLANTS—*paſſim.*

Theſe extraordinary movements and periodical revolutions of plants, certainly are not merely mechanical, neither can they fairly be attributed to a *real* perceptive faculty, which implies intellect; but more probably proceed from irritability, which imparts to every living thing a powerful tendency towards ſelf-preſervation. Hence the motion of their ſap, their nutrition, perſpiration, and ſingular power of regeneration from ſlips, or cuttings.

If the forked branch of an apple-tree be ingrafted, at its ſuperior points, into the neighbouring branches of two crab-trees, they ſupport it (though apparently ſuſpended in the air) by a friendly inoſculation, till at length they behold their foſter plant waving its fruit and foliage over their heads.

"*Miranturque novas frondes, et non ſua poma.*"

"Life," ſays the Biſhop of Landaff, "belongs alike to both the animal and vegetable kingdom, and in each of them it ſeems to depend on the ſame principle." By which muſt be underſtood the principle of irritability. Thus if we ſtop the motion of the fluids in an animal limb by a ſtrong ligature, it mortifies below the ligature, and drops off. A branch of a tree, under like circumſtances,

ces, withers and decays. Both animals and vegetables ſuffer from the extremes of heat and cold—from repletion and from inanition.—Both are ſtrengthened by air and motion—Both are liable to contract diſeaſe by infection—Both can ſuffer amputation, without being deprived of life—and both, in a ſimilar way, form a *callus*.

Plants not only reſpire air by their leaves, which amply ſupply the place of lungs, but alſo poſſeſs the property of decompoſing water, and ſecreting the vital air, one of the component parts of that fluid; while the other, the inflammable air, ſerves for their nutrition. Hence the vital air, which they ſo plenteouſly perſpire during the preſence of the ſun, and the noxious air, which they exhale (though in much ſmaller proportion) during the night.

Hence the vegetable kingdom, together with the ſun, and the waters of the ocean, conſpire to repleniſh the atmoſphere with vital air, ſo neceſſary to every living creature. Otherwiſe the daily waſte of that fluid, occaſioned by innumerable breathing animals, by combuſtion, by putrefaction, and other cauſes of its expenditure, could never be ſupplied.

From the irkſome effects of continued darkneſs, independent of temperature, both on men and plants, and from the enlivening effects of bright ſunſhine in evolving vital air, we learn why light is no leſs eſſential to animal than vegetable life: Why a ſenſe of languor or oppreſſion is generally felt during the darkneſs of a thunder-ſtorm: Why the preſence of the great luminary of day gladdens all nature: why a general gloom and melancholy overſpreads the creation when he ſuddenly withdraws his animating beams, or undergoes a total eclipſe: Why confinement in dungeons, independent of dampneſs, is ſo injurious to the health of priſoners: and why the meaner ſort of houſes in this country, ſince they have been darkened in conſequence of the heavy window tax, have been obſerved to exhibit a race of more pale and ſickly inhabitants.* Finally, why the gloomy chambers of the ſick are rendered more unwholſome, and acquire additional horrors, by indiſcriminately ſhutting out the cheerful beams of day: and why the malignancy of contagious fevers is often increaſed, by thus imprudently depriving the patient of one of the moſt exhilarating cordials in Nature.

It is curious to obſerve how the animal and vegetable tribes mutually ſupport each other, through their whole exiſtence. Vegetables purify the air for the uſe of animals, while the impure air expired by animals affords nouriſhment to vegetables. It is no leſs obſervable, that the common air which preſerves organized bodies during life, deſtroys them after death, by promoting putrefaction, and by converting them into food for a freſh ſucceſſion of vegetables, which, in their turn, yield ſuſtenance to a ſucceeding race of animals.

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* This fact was repeatedly remarked, in his different journeys, by Mr. Howard, the benevolent inſpector of priſons; though he does not appear to have been acquainted with the properties of light as connected with vital air, the knowledge of which might have pointed out many important improvements in addition to thoſe which he has propoſed.

In the living ſtate, the vital power reſiſts this action of the air, but when life is extinct, both animals and vegetables yield to the general law which haſtens their decay, becauſe dead ſubſtances would only encumber the creation; whereas by ſpeedy diſſolution, the elementary particles of matter become fit to aſſume new forms, and undergo new combinations in the ſcale of exiſtence.

With what ADMIRABLE ŒCONOMY has the SUPREME ARCHITECT eſtabliſhed this reciprocal intercourſe between the animal and vegetable kingdoms, for the benefit of Man! By what ELEGANT SIMPLICITY OF DESIGN are the different parts of Nature thus rendered at once ſubſervient to the mutual ſupport of each other reſpectively, and to the general well-being and harmony of the Whole!

33. Having endeavoured to explain animal heat and irritability, and traced their origin to vital air, we ſhould next proceed to account for

SENSIBILITY and voluntary motion, or that cauſe (whatever it is) that actuates the brain and nervous ſyſtem. But as this has hitherto baffled every reſearch, it is with extreme diffidence that we now hazard even a conjecture concerning it.

Nature, ever uniform in her works, produces her moſt important operations by the ſimpleſt means; we muſt therefore beware of multiplying unneceſſary cauſes.

The nervous influence, or, as Dr. Darwin elegantly expreſſes it, the Spirit of Animation, cannot be a ſecreted fluid, ſince the brain is no longer allowed by anatomiſts to be a ſecretory organ.

Neither can its origin be proved to be coæval with the unformed rudiments of the embryo, when the "*dim ſpeck of entity*" firſt becomes viſible, for then no veſtige of brain or nerves can be diſcerned.

Muſt it not be referred then to vital air or ſpirit of the atmoſphere, emphatically termed in the Sacred Page, the "BREATH OF LIFE," and by ancient philoſophers, "*Divinæ particula auræ*," drawn into the lungs at the firſt effort of reſpiration? Is this received in form of heat, light, or electricity? Or, to ſpeak more philoſophically, is it that ſubtile fluid, which fills univerſal ſpace; pervades all bodies; and actuates every particle of matter; of which, heat, light, and electricity are only effects, or different modifications of the ſame cauſe?

That the principle of heat and electricity bear a ſtriking analogy to each other, is evident from various circumſtances. Thus, both originate in the atmoſphere—Both enter the compoſition of bodies in a latent ſtate—Both may be excited by attrition, and aſſume the form of light, as well as of ſenſible heat—Both ſtrive to preſerve an equilibrium—Both are capable of pervading the denſeſt bodies, and of melting metals—Both promote the evaporation of fluids—Both accompany lightning, fiery meteors, and volcanic eruptions.—Bodies, which are the beſt conductors of electricity, are alſo the beſt conductors of heat—Both act on the irritable parts of plants and animals—Finally, both excite muſcular action, and increaſe the ſenſibility of the nervous ſyſtem.

They differ, however, very materially in ſome reſpects.

Heat diffuſes itſelf equally to all ſurrounding bodies—Electricity attaches itſelf to ſome particular ſubſtances in preference to others.—Heat is communicated ſlowly—Electricity moves with rapidity.—The effects of the former are progreſſive—thoſe of the latter inſtantaneous. The celerity of electricity keeps pace with the celerity of volition, and therefore ſeems more peculiarly adapted to explain the phenomena of the nervous ſyſtem. When Louis the XVth, from a motive of curioſity, commanded a battalion of 2000 men to ſtand hand in hand, and receive the electrical circuit through their bodies, the laſt man felt the ſhock, at the ſame inſtant with the firſt. So in the act of volition, the moment the mind wills the hand to be moved, it is moved; but without our being conſcious of the manner *how;* becauſe it was not neceſſary we ſhould know it was done by the mind directing the nervous influence into the moving fibres of the part.

As the mind governs the body, it evidently employs the nerves to execute its commiſſions, and to tranſmit its various impreſſions from the brain to the extremities, and back from the extremities to the brain. To complete this chain of connection between mind and matter, it was neceſſary the nerves ſhould convey a fluid medium of extreme mobility, tenuity, and elaſticity; in a word, exactly ſuch a one as we now know the electrical fluid to be. Though the nerves are the organs of voluntary motion and ſenſation, and when ſtimulated excite the irritable fibres into action, yet have they no motion or irritability of their own, however irritated. Whence they are to be conſidered as conductors, rather than the active agent, or proximate cauſe of muſcular motion.

That they convey a ſubtile fluid, which actuates the voluntary organs, ſeems indiſputable; and though the perfect identity between this fluid and that of electricity has not been yet clearly aſcertained,

certained, yet the late curious diſcovery accidentally made by M. Galvani, and ſince purſued in a courſe of experiments by M. Valli, ſeems to confirm it, and alſo to bid fair to throw new light upon this intricate ſubject. The reſult of their reſearches, being publiſhed, need not here to be repeated.

If there be any deception, in this otherwiſe remarkable diſcovery, that may have impoſed on theſe ingenious foreigners, it muſt depend on the facility with which ordinary electricity may under certain circumſtances be excited. Mere motion of non-conducting bodies, without any apparent friction, is alone ſufficient to diſturb the equilibrium, and produce electrical phenomena—A circumſtance to which philoſophers ought to be very attentive in repeating the experiments, before they can draw any poſitive concluſions.

That certain animals, however, poſſeſs a power ſimilar to electricity in every reſpect, except that of yielding viſible ſparks, is evident from the effects of the torpedo, and electrical eel. In the ſtructure of theſe warlike fiſhes, has been diſcovered a curious electrical apparatus, over which they have complete command, and from which, in all directions, they can at pleaſure deal out powerful electrical ſhocks. Thus armed at all points, they are prepared to act on the offenſive or defenſive—to attack their prey, or to repel an enemy, as occaſion may require.

34. Let us ſuppoſe then that the nervous ſyſtem, like the electrophorus, when once charged with poſitive and negative electricity, will continue, on being approached by a conductor, to exhibit electrical phenomena. That, moreover, this animal electricity, when actuated by the mind, will excite the muſcles to perform voluntary motions, correſpondent to the act of volition.

That, whenever the equilibrium between the poſitive and negative electricity is diſturbed by the contact or impulſe of external bodies, applied to the organs of ſenſe, it will tranſmit the impreſſion to the ſenſorium, when the mind will inſtantly return a faithful idea of the ſenſation thus excited.

When the nerve belonging to any muſcle is divided, this intercourſe is cut off, and the muſcle becomes motionleſs; but if the wounded part is armed artificially with a conductor of electricity, the communication is reſtored, and the muſcle renews its contractions. All which has been verified by experiment, not only on amputated limbs, but ſeparate muſcles.

35. Let us next ſuppoſe that, the nervous electricity, like the principle of irritability, is ſubject to 3 different ſtates, viz. accumulation, diminution, and tone.

If the natural ſtimuli are defective, it will be accumulated; if too powerful, or too long continued, it will be proportionably diminiſhed. If a due medium is preſerved, it will conſtitute tone, or harmony of the nervous ſyſtem.

As the nervous influence is liable to be diſſipated by acts of volition, cogitation, and aſſociation, as well as by external ſtimuli applied to the organs of ſenſe; it will require to be daily repleniſhed from the atmoſphere, and the ſurplus only, to be carried off. Hence the neceſſity of alternate action and repoſe, to preſerve the balance of health; and theſe will be more or leſs perfect, according as the equilibrium of the nervous influence is kept more or leſs entire. As reſpiration continues during ſleep, while all the voluntary motions ceaſe, this fluid muſt, during that period, be conſiderably accumulated. Hence may be explained the languor and fatigue occaſioned by ſevere exertions of body and mind, or long watching. Hence the new vigour and alacrity experienced by the weary traveller, from the balmy reſt of a ſingle night's repoſe.

Admitting the analogy, if not perfect identity between the nervous fluid, and that of electricity, may we not infer, that different degrees of excitement will produce different degrees of ſenſibility? That every exceſs or diminution of excitement, beyond what is natural to the age and conſtitution.

on, will cauſe a proportionate deviation from the equilibrium requiſite to health, and conſequently erminate in diſeaſe? Hence the acute ſenſibility of youth, and the torpid ſtate of old age. Hence oo, the different degrees which mark the temperaments of individuals, through all the ſtages of ife.

From exceſſive excitement may be explained hy in certain diſeaſes of the nerves, the organs f ſenſe become impatient of their wonted ſtimuli, hy light becomes painful to the eye, and ſound o the ear.

Why in gout, or other nervous affections, perons are ſo ſuſceptible of every ſudden change of eather. And why, in ſuch haſty tranſitions, particularly in thunder-ſtorms and tempeſts, they feel nglings in the fleſh or ſhooting pains, like electril vibrations, through different parts of the body; hich, though attributed to heat or cold, more robably depend on the equilibrium of the atmoſheric electricity being ſuddenly diſturbed.

Why in the hyſteric and epileptic paroxyſm, here the nervous influence is violently excited in rticular parts, or the equilibrium between the ſitive and negative electricity ſuddenly deſtroy-, particular muſcles are ſtrongly convulſed, and e limbs thrown into dreadful contortions. Why otal loſs of excitement in the paralytic arm occaſions an accumulation in the oppoſite one, and forces it into more frequent and un-uſual motion.

Why in vehement paſſions of mind, the eyes preſent phenomena, perhaps, not eaſy to be explained on any other principle than that of ſympathy dependent on nervous electricity. Whence otherwiſe, ſhall we account for that faſcinating power of the eye, in expreſſing the various emotions of the ſoul?

Why, according to the degree of excitement and the nature of the paſſion, the human eye i equally calculated to beam with benign radiance or to flaſh with indignant lightning? Hence th impaſſioned eye is ſeen to ſparkle with joy—t gliſten with pity—to ſhed tears in grief. Henc the language of the eyes is univerſally underſtoo even by illiterate people of all nations, and is allowed by lovers to be far more eloquent than tha of ſpeech. Hence thoſe brilliant emanations dar ed from their eyes, when their boſom glows wi intenſe paſſion. Hence thoſe fiery ſcintillation when it is inflamed with jealouſy, or burns wi inexorable rage.

From the ſame principle, may likewiſe be e plained, why ſudden horror occaſions the hairs the head to ſtand on end, as if powerfully excit by an electrical conductor. Why anger prod ces the ſame effect, on the quills of an incen porcupine.

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Why medical electricity is found to be ſo powerful in exciting the energy of the nerves, as to force the paralytic limb into involuntary motion; and to renew action, in vital ſuſpenſion, longer than any other ſtimulus hitherto diſcovered.

Hence its utility in the cure of nervous diſeaſes, eſpecially where ſenſibility is greatly diminiſhed.

Hence, likewiſe, the reaſon why friction with the hand, or a fleſh-bruſh, by exciting the nervous electricity, rather than by mere exerciſe, contributes to the cure of ſimilar affections.

36. Now how far this theory, which at preſent, is only offered as a probable hypotheſis, ſhall be found more conſonant to the laws of the œconomy, in explaining the phenomena of the nervous ſyſtem, than thoſe of preceding writers, muſt be left to future inquiry.

Meanwhile, whether the myſterious agent, which is the proximate cauſe of ſenſibility, conſiſts in ordinary electricity, or ſome other modification of that ætherial fluid which pervades the univerſe (by whatever name it may be diſtinguiſhed), matters little; provided it is found to be a conſtant principle in the nervous ſyſtem, and perfectly adequate to the effect. The facts, in either caſe, remain the ſame, and it would be fruitleſs to diſpute about words.

Having, upwards of twelve years ago, entertained nearly the ſame idea on this ſubject, it naturally led me to the following concluſion, viz. that irritability *immediately* depended on vital air; but the nervous influence; on electricity. Upon which foundation, a new ſyſtem of late has been haſtily erected, though with profound ſilence, but ſo greatly encumbered with ſuperfluous groteſque ornaments, as to injure the ſimplicity of the original deſign, if not endanger the whole ſuperſtructure. My further inferences were theſe, viz. "The popular idea, that life quits the body, in an aerial form, at the inſtant reſpiration ceaſes, appears to be erroneous."

"That, on the contrary, the principle of irritability, being an innate property of the living ſolids, maintains its reſidence in the vital organs, a conſiderable time after motion and ſenſation have ceaſed."

"That the principle of ſenſibility or nervous influence, like that of ELECTRICITY, to which it bears ſuch a *ſtriking affinity*, often remains in a dormant ſtate, without betraying the ſmalleſt ſign of its preſence, till it happens to be rouſed by the proper modes of *excitation*." *

The doctrine, therefore, of Nervous Electricity, which of late has fixed the attention of the Philoſophical World, and which Dr. Galvani's diſcovery undoubtedly tends to illuſtrate, is not ſo perfectly *new* as is generally imagined.

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* Hints on Animation, &c. by *A. F.* in 1783.

SECT. XII.

PROGNOSTIC *in Vital Suſpenſion*—CAUSES *which influence Recovery*—SIGNS *of the Preſence of Vitality*—*Of its total Abolition.*

37. Amongſt the various caſualties to which we are particularly expoſed, in this our inſular ſituation, bounded by the ocean, and interſected with numerous rivers, and navigable canals; it is no wonder, that thoſe from drowning are far the moſt numerous.

In perſons ignorant of the art of diving, drowning is, perhaps, generally effected in leſs than 10 minutes ſubmerſion. To which, however, the accounts delivered to the Society ſeem to afford many exceptions. Accordingly we find ſome are ſaid to have been reſtored from drowning, after 20, 30, nay 45 minutes! * This laſt is the only inſtance of recovery after ſuch long ſubmerſion, out of upwards of 600 ſucceſsful caſes. Nor is it difficult to conceive how it happened, as the man was obſerved to float on the ſurface of the water, the greateſt part of the time; and conſequently might reſpire air at intervals. But why ſome of the reſt ſurvived 20 or 30 minutes, while others were irrecoverably drowned in leſs than 3, no circumſtance is mentioned ſufficient to account for ſuch a ſtriking difference in the event!

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* But what is even this, when compared with the miraculous inſtances recorded by certain grave hiſtorians, who re-count recoveries of this nature, not by minutes or hours, but by days or entire weeks? Kunckel, having related many examples of this ſort, adds, "that in Sweden no one doubts the poſſibility of retaining life under water, for the ſpace of 8 days"! Burmann, not to be behind-hand with him, retails the caſe of a man, who continued under water 7 *weeks*, notwithſtanding which he not only recovered, but enjoyed health many years after!! Such examples of the marvellous ſeem not unworthy the inventive genius of the author of Baron Munchauſen's unparalleled adventures!

38. From what has been remarked, however, concerning the effects of drowning (1-5), and other modes of ſuffocation (6—7—10), it ſeems evident, that whatever previouſly injures reſpiration (13—18), or diminiſhes the natural heat (19—21), the irritability (30—31), or ſenſibility of the ſyſtem (32), muſt not only haſten on a ſuſpenſion of the vital powers (29), but alſo retard recovery.

Hence it is eaſily underſtood, why the following circumſtances muſt be conſidered as very unfavorable, in the article of drowning.

1. A plethoric, aſthmatic, or hectic habit. 2. Intenſe cold, or ſubmerſion under ice. 3. Water imbibed into the lungs. 4. Intoxication. 5. Timidity. 6. Horror.

This laſt, probably, ſurpaſſes all the reſt, for when extreme terror ſeizes a poor timid ſufferer, deſtitute of preſence of mind, the terrific idea at once arreſts the principle of life, and inſtantly cuts off every reſource. Hence may be conceived why ſome periſh irrecoverably during the firſt moments of ſubmerſion.

On the contrary, why a firm habit, ſobriety, fortitude of mind, and a warm ſeaſon may all tend to protract life, and facilitate recovery. If to theſe be added a ſkill in diving, an accidental floating of the body with the face upwards, or above all, the *foramen ovale* remaining open * (as in ſome rare inſtances happens through life), we may account why certain perſons reſiſt the watery element ſo much longer than others. And why a few remarkable eſcapes of this ſort have, in former times, been exaggerated into miracles, and given riſe to the moſt incredible ſtories.

Though our prognoſtic, in all ſuch critical caſes, as thoſe of apparent death, muſt ever be doubtful, yet a careful attention to the above circumſtances (37—38), may generally aſſiſt us in forming a tolerable conjecture concerning the probability of ſucceſs.

If the eyes appear clear, the pupils not greatly dilated, nor totally void of contraction, on being approached with a lighted taper: If the external muſcles can be made to ſhew viſible contractions by electricity: and, finally, if the ſurface of the body retains perceptible warmth, we may conclude, though every other appearance be unfavorable, that ſenſibility and irritability have not wholly forſaken the vital organs, and conſequently that there are ſtill ſome hopes that recovery may be effected.

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* Becauſe the blood, finding this paſſage ſtill open as in the mbryo ſtate, paſſes on from the right to the left ſide of the eart, without being obliged to perform its wonted circuit, hrough the ramifications of the lungs. Hence, it is eaſy to ſee ow the circulation may be thus tolerably carried on for ſome ime, even after reſpiration is ſuſpended.

On the other hand, if the eyes appear miſty or ſuffuſed—the pupils deſtitute of contraction—the countenance livid—the body ſtiff, cold, and inſenſible to ſtimuli, the caſe would ſeem deſperate: but as our ſenſes are ſo liable to deceive us, we ought not yet to pronounce it totally irrecoverable, eſpecially as ſome few, though equally unpromiſing, are *ſaid* to have been reſtored. Though the body to the touch may feel as cold as marble, yet a thermometer placed under the tongue, or any other cavity not expoſed to the outward air, may ſerve to detect the fallacy, and enable us to form a more correct judgment concerning the real temperature. Though electricity, in ſo deſperate a ſituation, may be unable to excite any viſible contraction in the external muſcles, we cannot ſee whether it may not ſtill affect the heart, which retains its irritability ſo much longer (31).

It therefore cannot be, as ſome reſpectable wri ters imagine, a certain criterion of the preſence or abſence of vitality.* Neither does it warrant us, under theſe circumſtances, to abandon the patient as abſolutely dead.

For this would induce us to neglect the neceſſary means by which others have been reſtored, even where apparent death had aſſumed its moſt formidable ſhape: Where no pulſation of the heart—no contraction of the pupil of the eye—nor any viſible mark of reſtoration could be produced, till after 3 hours diligent perſeverance in the treatment recommended by our Humane Society.

Electricity, however, under ſuitable reſtrictions, may ſtill be employed with great propriety, not as a *certain* but a *probable* teſt of the extinction of life, or of the degree of irritability ſtill remaining in the vital organs. A knowledge of this may alſo be highly important in directing us how to proportion the degree of ſtimulus to the degree of irritable power; and how to re-kindle the feeble ſpark without extinguiſhing it.

All the external ſigns of departed life have hitherto occaſionally proved fallacious. Hence neither the clay-cold hand, the rigidity of the limbs, the dilation of the pupil, nor even the cadaverous countenance are, ſeparately conſidered, infallible teſts of its total extinction. Nay, even putrefaction itſelf, though allowed to be the moſt unequivocal ſign of abſolute death, might chance to deceive us in that ſyncope, which ſometimes ſupervenes the laſt ſtage of the confluent ſmall-pox, ſea-ſcurvy, or other highly putrid diſeaſes. Sometimes death is ſo ſtrongly marked in the viſage, as not to be miſtaken by the moſt ordinary ſpectator: At others, the features remain unaltered many hours after deceaſe, and the countenance wears an aſpect of ſerenity unknown even in health, ſo as to impoſe, at firſt, on the moſt accurate obſerver. Hence, it is by no means eaſy to eſtabliſh a ſure criterion, either of the preſence or abſence of life. In the latter, however, there is generally obſervable, a peculiar dimneſs of the eye reſembling ſemi-tranſparent glaſs, accompanied by a flaccidity of the ſkin, with a peculiar coldneſs and collapſed appearance of the external parts of the body.—An appearance not eaſily deſcribed in words, though it has often been copied from Nature, and ſometimes admirably expreſſed upon canvaſs, by certain eminent Painters, as Michael Angelo, Rubens, Titian, &c.

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* See Mr. Kite's Eſſay on apparent Death. p. 125.—Baron de Hupſch. Eſſ. &c.—Reports of the Humane Society of London. . 441.

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E. Penny del. J. Corner sc.

Apparent Dissolution.

Engrav'd from the Original, by Permiſsion of the Proprietor.

SECT. XIII.

NATURE'S *Prôceſs in reſtoring Animation—in the Human Species—in certain dormant Animals.*

39. Before we can form a juſt eſtimate of the comparative merit of any general mode of treatment, or of the efficacy of the particular remedies of which it conſiſts, we ought to have a previous knowledge of what Nature unaſſiſted by art *can*, or *cannot* perform in reſtoring animation. To determine which with certainty, would require a multiplicity of experiments, not merely on brutes, but on the human ſpecies. But the latter (though the neceſſary data are wanting) we are by no means authorized to undertake, and hence may juſtly complain, in the words of the venerable Father of Phyſic, "*Experimentum difficile!*" The Public, however, is indebted to Mr. Kite for the reſult of ſome trials, inſtituted with this view, on drowned animals. After the ſtrugglings had ceaſed from the ſpace of 1 minute to 4, if they were expoſed to the open air, they ſoon recovered ſpontaneouſly, but ſeldom, or ever, after the 6th or 7th minute. By imitating natural reſpiration *alone*, he was able to reſtore ſome animals after 8, 10, or 12 minutes ſubmerſion, but candidly acknowledges,

that this operation, though performed with great attention, often failed; while other animals, that had been immerſed longer, recovered ſpontaneouſly. He further adds, that if it be not attempted before the convulſive motions of the animal ceaſe, which, on an average of many experiments, happens in about 11 minutes and a half, it will not be ſufficient to renew the vital functions.*

Among the human ſpecies, however, there are not wanting well-authenticated inſtances of ſpontaneous recovery, at an incomparably longer interval, and after every external mark of life had diſappeared. Such is the latent energy of the heart, that it ſometimes, after remaining ſeveral hours quieſcent, renews on a ſudden the ſecret ſprings of life, ſurmounts the barriers of the reſiſting blood, and reſtores circulation with all the other functions. Hence the unexpected recoveries from death-like ſyncope brought on by ſudden terror, or great effuſions of blood, even after the funeral obſequies have been prepared. Such, are ſometimes the ſurpriſing efforts of Nature, in reſtoring vital action without any viſible aid! therefore wholly inimitable by art. But when her own internal reſources prove inſufficient to repel the danger, ſhe occaſionally avails herſelf of external or adventitious circumſtances, and theſe of the ſimpleſt kind, ſuch as accidental motion or moderate heat. Hence, ſome perſons have accidentally been brought to life, even after interment, by the rude motion produced in ſacrilegious attempts to wreſt rings or bracelets from the apparently dead body. Hence, drowned perſons, in more than one inſtance, have been reſtored by the enlivening rays of a warm ſun. Hence too, dormant animals, that remain torpid during the winter, are regularly reſtored to life and activity, by the genial warmth of ſpring. The analogy, which obtains between this ſtate of torpor, and apparent death, is ſo ſtriking, and at the ſame time ſo applicable to the preſent ſubject, that it ſeems to deſerve more attention than has yet been beſtowed upon it. Our readers, it is preſumed, will not be diſpleaſed with the following entertaining paſſage from that celebrated Natural Hiſtorian M. de Buffon.

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* Memoirs of the Medical Society of London. Vol. 3. p. 297.

"This claſs of animals," ſays he, "are not in a ſtate of natural ſleep, as is commonly imagined—they are in a ſtate of torpor, which is produced by the coldneſs of their blood, by which they loſe the uſe of their limbs and ſenſes. Their internal heat indeed is ſo ſmall, that it ſcarcely, at any time, exceeds that of the air; ſometimes falls one degree below it. When the temperature of the air is reduced to 11 degrees above the freezing point, I have repeatedly obſerved their internal heat near the heart to mark only 10 degrees by the thermometer. There is little reaſon then to wonder, why theſe animals ſo inferior comparatively to others in point of heat, ſhould become torpid, as ſoon as their own ſmall portion of internal heat ceaſes to be aſſiſted by the external warmth of the air: a circumſtance which naturally happens, when the thermometer is not more than 10 or 11 degrees above congelation. The ſame extends to all torpid animals, during the winter. Alike are its effects on the dormouſe,* the hedge-hog, and the bat. Of this claſs, the marmot is the moſt remarkable, which delights in the regions of ice and ſnow, and is never found but on the higheſt mountains: it, nevertheleſs, of all others, is the moſt liable to be rendered torpid by cold.

Theſe animals, though extremely active in ſummer, lay up no proviſion for the winter, becauſe ſuch a precaution would be uſeleſs during their dormant ſtate. But when they perceive the firſt approaches of the ſeaſon, in which their vital motions are to continue in a great meaſure ſuſpended, they cloſe up the apertures of their ſubterraneous dwellings with ſuch ſolidity, that it is more eaſy to open the earth any where elſe, than where they have cloſed it. When their retreat is diſcovered, they are found, each rolled into a ball, and apparently lifeleſs. In this ſtate, they may be dragged roughly along the ground, or even killed, without their teſtifying any ſenſe of pain. The blood, un-renovated by freſh chyle, is cold, and entirely without ſerum: the circulation is, probably, confined to the trunks of the larger veſſels.

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* In a room, the air of which was at 64, the internal heat of a dormouſe which had been aſleep, proved in Mr. J. Hunter's experiments equal to 80. But in a temperature of 64, the animal was probably in its natural ſtate of ſleep, not torpid: Its heat, while torpid, though beyond that of the marmot, perhaps rarely equals 80 degrees." Phil. Trans. Vol. 68. p. 19.

By a *mild and gradual heat alone*, are they to be recovered from this torpor, and if brought ſuddenly before a *fire*, they *periſh*. A few degrees of heat above the 10th or 11th degree are ſufficient to re-animate them; and if they are kept in a warm place during the winter, they do not become torpid, but continue as lively as at any other time. If the marmot remains longer torpid than the dormouſe, it is probably, becauſe the weather of the climate it inhabits is longer cold."

"It is curious," adds M. de Buffon, "to obſerve this animal, when he is prematurely forced to paſs from the torpid to an active ſtate. He firſt yawns, fetches *a deep ſigh*, and utters broken, inarticulate ſounds like a drunken man. His limbs become leſs rigid, he ſtretches out his legs, fetches another ſtill deeper ſigh, opens his eyes, and at length recovers. Such are the uneaſy ſenſations he viſibly undergoes, from a ſudden and forced re-animation; which is, probably, performed in a more gentle and imperceptible way by the vernal warmth, when left in his cell. But what is ſingular, he never becomes torpid, though expoſed to a degree of cold, equal to that of freezing, provided he is kept in the open air, inſtead of a cloſe place."*

From the circumſtance of theſe animals excluding all communication with the external atmoſphere, may not the ſtagnant air of the cell, contaminated by their reſpiration, and ſaturated with carbonic gas, add conſiderably to the ſedative effects of cold in bringing on torpor?

This, and many other particulars, unnoticed by writers of Natural Hiſtory, muſt be left as objects of inquiry for future inveſtigation.

Whether, for inſtance, their circulation and reſpiration are wholly, or only partially ſuſpended?

Whether the foramen ovale remains open during life? Whether the ſtructure of their heart and lungs is the ſame as in other perfect animals, while their generating power of heat is ſo much

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[*] Natural Hiſtory of Animals. Vol. 2. p. 254. Kenrick's Edition.

inferior?[*] Whether the blood is florid in their active ſtate, and whether it acquires a black hue during their torpor? Finally, whether they loſe both ſenſibility and irritability, as ſome writers relate, or whether they are capable of being reanimated by electricity and other ſtimuli, independent of heat?

At all events, it muſt be acknowledged, that intenſe cold, by its ſedative effects, is ſufficient to induce upon other animals, when inactive, a ſtate of torpor, and even death. If Man is much leſs liable to become torpid by cold than the dormant tribe, it is perhaps, becauſe he enjoys a much greater and more ſteady portion of natural heat: but when this is ſuddenly reduced below a certain point, by expoſure to extreme cold, he alſo is forced to yield to the ſedative power. A drowſineſs firſt ſteals over the ſenſes—the blood runs cold—then, torpor invades the whole frame!

"———————*And down he ſinks*
Beneath the ſhelter of the ſhapeleſs drift,
Thinking o'er all the bitterneſs of death:
Mix'd with the tender anguiſh, Nature ſhoots,
Thro' the wrung boſom of the dying man.
———————*On every nerve*

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[*] That this, however, is very conſiderable in the dormouſe when life is in danger, appears from Mr. Hunter's experiment, ſince its heat at 81 roſe to 93, on the animal being confined in an atmoſphere ſo low as 20 degrees. Phil. Tr. Ibid.

The deadly winter ſeizes; SHUTS UP SENSE;
And, o'er his inmoſt vitals CREEPING COLD,
Lays him along the ſnows, a STIFF'NED *corſe,*
Stretch'd out, and bleaching in the northern blaſt."

Thomſon's Seaſons. p. 175.

When this ſtate of torpor or apparent death is brought on, whether in the marmot, or the man; whether by the ſedative effects of cold, or by ſubmerſion, the phenomena in both are extremely ſimilar. Both are bereft of ſenſe and motion—Both loſe a large portion of animal heat—Both are reſtored by a gentle degree of warmth, but deſtroyed by too great, or too ſudden heat—Both, on their firſt recovery, exhibit ſimilar efforts towards reſtoring reſpiration and circulation.

If the recovery of the marmot is more uniformly certain, it is not only becauſe in him, the torpor is more gradual, but becauſe the degree of heat is regulated by the ſteady, unerring hand of Nature; in Man, by the uncertain, capricious rules of Art.

In high northern latitudes, it is reported, that eels, during the cold ſeaſon, are frequently ſent to diſtant places in a frozen ſtate, where afterwards by immerſion in cold water, they are thawn, and gradually reſtored to life. Nor will this appear altogether incredible when it is conſidered, that not only eels, but frogs and vipers can bear their natural heat to be reduced by a frigorific mixture, to, at leaſt, one degree below the point of congelation, without being deprived of life. To ſome, this experiment proves fatal, while others remain apparently dead many hours, but afterwards recover.*

When through expoſure to extreme cold, the fingers, or other external parts of the human body are frozen, the heat in theſe parts muſt neceſſarily be reduced to the loweſt point conſiſtent with life. If artificial heat be ſuddenly applied, a mortification enſues, and the parts drop off. But if they are firſt thawn by friction, with ſnow, and gentle warmth be then gradually applied, the parts are ſoon reſtored to their wonted uſe and activity.

Having thus far conſidered the means, which NATURE points out for reſtoring men, and other animals from apparent death; we next proceed to examine thoſe, which have been ſuggeſted by ART.

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* Phil. Tranſ. loco cit.

SECT. XIV.

PRINCIPAL INDICATIONS.—*Review of the preſent Artificial Method of Treatment.*

40. From the moſt authentic information we have been able to obtain, whether from experiments on drowned animals, or obſervations on the human ſubject, it ſeems clear that in all ſucceſsful caſes, the firſt efforts towards recovery began in the organs of reſpiration, ſuch as a tremulous motion of the lips, convulſive ſobbings, with other imperfect attempts towards breathing: next a deep inſpiration, with an obſcure motion of the heart, and then the other functions gradually followed in ſucceſſion, but not till reſpiration was reſtored.

Having, in addition to this conſideration, traced the PROXIMATE CAUSE of ſuſpended reſpiration to the Excluſion of Vital air (13—29), and alſo ſhewn the connection between reſpiration and the action of the heart and other vital organs (30—33); our Readers will readily anticipate us in drawing the following concluſion, viz. That the 1st GRAND INDICATION is to RENEW THE ACTION OF THE LUNGS, IN ORDER TO OPEN A FREE PASSAGE TO THE BLOOD THROUGH THAT ORGAN:

Secondly, TO EXCITE THE ENERGY, OR

PROPULSIVE POWER OF THE HEART, IN ORDER TO ENABLE IT TO OVERCOME THE RESISTANCE.

Accordingly we find, that if thoſe 2 organs can be happily brought to act once more in uniſon; the blood will inſtantly renew its wonted circuit, and the vital and intellectual functions will naturally follow in their order (29). The natural ſtimuli, by which the former are kept in motion, are vital air and warm blood; and when their action is accidentally ſuſpended, the means employed by Nature are (as we have ſeen) the ſimpleſt imaginable; conſiſting of nothing more than merely reſtoring the warmth and motion which they had loſt (39). The methods contrived by Art, on the other hand, are various and complex; being uſed alſo conjointly, or in quick ſucceſſion, it is by no means eaſy to determine, to which of them the ſucceſs ought to be attributed. Let us examine, however, their reſpective merits, and ſelect thoſe that appear beſt calculated to anſwer the end, by the moſt direct means.

To propoſe any deviation from the methods, which have been attended with ſuch apparent ſucceſs, and which, with little variation, have been adopted by the learned of the Faculty, in ſo many different parts of Europe, may perhaps, at firſt view, ſeem preſumptuous, if not un-

warrantable.

But the queſtions propounded by the Royal Humane Society afford ample apology, as they evidently imply that, the art of reſtoring animation (notwithſtanding its wonderful progreſs), has by no means yet arrived at its *ne plus ultra;* but, on the contrary, ſtill affords ſufficient room for improvement. We ſhall therefore, in obedience to their requeſt, reſpectfully ſubmit to their conſideration, a few remarks.

Veneſection.

41. From the apparent accumulation of blood in the right cavity of the heart and neighbouring veſſels, veneſection, it is true, might ſeem indiſpenſably neceſſary. But when we conſider, that the quantity of blood, which can be ſafely drawn from the veins, cannot ſenſibly diminiſh the ſuppoſed congeſtion near the heart: That if the right cavity is too full, the left is proportionably empty: That the general maſs is in no-wiſe increaſed: That the heart and other hollow muſcles cannot act with due force, unleſs moderately diſtended: and that tenſion gives tone and vigour to the whole frame; we cannot but heſitate as to the propriety of this operation. But how much more ſo when to this we add, that bleeding, inſtead of increaſing the action of the heart, and energy of the

brain, has a manifeſt tendency to weaken both; and that in caſes of debility, which bear no proportion to this, it often produces faintings, convulſions, and death? Therefore, unleſs we reſolve to hazard the feeble remains of life (to ſupport which our utmoſt exertions ſhould be directed), we muſt forbear this operation, at leaſt, till he circulation be reſtored.

On the other hand, however, it is inſiſted upon by the advocates for congeſtion and mechanical obſtruction, that "bleeding is the firſt thing neceſſary, and ought to precede all other means; particularly, becauſe the letting out part of the blood from the right cavity of the heart of a drowned animal, by means of a puncture, has been obſerved to renew the contractions, by diminiſhing the diſtention." But is it not eaſy to onceive how this might happen, independent of he evacuation, by the mere irritation occaſioned by the puncture? But admitting the contrary ppoſition, could ſuch an operation be ſafely ndertaken in the living ſubject? Nay, if it even ould, would it not probably, inſtead of forwardg, retard the main intention, by diminiſhing e ſtimulus of tenſion neceſſary to the action of at organ? Whence is it that the motion of the ght cavity ſurvives that of the left, but from the perior quantity of oxygenated blood which it ntains? or, why do perſons recover with greater facility from a common ſyncope, than from other ſpecies of vital ſuſpenſion; but that in the former caſe, the left cavity ſtill contains a conſiderable portion of blood, while in the latter, it is nearly empty? Were both cavities formed to contain exactly the ſame quantity, the equipoiſe being ſo nicely balanced, neither could begin to act, conſequently both would remain quieſcent.

Therefore, though this diſtention of the righ cavity, has been very generally conſidered as the grand obſtacle to our endeavours, it may perhaps ultimately be found one of the moſt happy inſtruments of recovery; this being evidently the *dernier reſſource* of IRRITABILITY (28—31). Here the feeble remnant of life, as if reluctant to qui its reſidence, lingers to the laſt moment. Here as in its citadel, it collects its remaining force, an calls forth every exertion to preſerve the principle of vitality to the laſt extremity. The bloo is the friendly ſtimulus, to which the heart ha been ever accuſtomed, and of which it is neve wearied. It is this, that rouſes it into action, i proportion to the reſiſtance it meets with, and th danger it has to encounter. Were it not for thi no eſcape from ſo critical a ſituation as that of apparent death, could ever be effected. It has, on th contrary, been alleged, with much plauſibility, tha whatever tends to increaſe the diſtention of its rig cavity muſt increaſe the difficulty; Hence frictio

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nd ſtimulants, by adding to the accumulation, be-
ore the obſtruction is removed, are ſuppoſed to
ave a deſtructive tendency. But if the right ca-
ity is already completely full, how can it be con-
eived capable of receiving any more from a
ropulſive power acting *a tergo*? Inſtead of which,
ould not ſuch impulſe tend to urge forwards to
he left cavity, now almoſt empty, the intermediate
olumn of blood; ſince there is a direct commu-
ication from one cavity to the other through the
ungs? And would not this, inſtead of being in-
urious, prove an important ſtep towards the main
bject in view, viz. the renewing the action of the
eart and arteries, and conſequently of reſtoring
he circulation? But as a farther illuſtration—

At every full expiration, the lungs undergo a
artial collapſe, and if the next inſpiration be vo-
untarily poſtponed a few minutes, the blood
eing retarded in its paſſage through the pulmona-
y veſſels, begins to accumulate in the right cavi-
y of the heart, as appears from the uneaſy ſenſa-
on felt in the cheſt. In proportion as the accu-
ulation adds to the anxiety, it creates alarm,
d the heart increaſes its exertions to overcome
e reſiſtance. By theſe efforts, the heart is en-
bled to propel the blood through the lungs, and
pport an obſcure circulation ſeveral minutes af-
r reſpiration is ſuſpended; particularly where this
wer is improved by habit, as was noted in the

caſe of diving (27). On the other hand, it has been ſhewn, that if an animal is ſtrangled at the inſtant an inſpiration has been made, the lungs, inſtead of being collapſed, are expanded; and conſequently no accumulation of blood can take place in the right cavity of the heart, or pulmonary veſſels; and yet the event proves as ſuddenly fatal as when the operation is performed under oppoſite circumſtances (22).

On the whole—if bleeding can ever be neceſſary on theſe occaſions, it muſt be where the ſuſpenſion is preceded by a highly plethoric or apoplectic habit, by intoxication, contuſion of the head or ſtrangulation. Here, the diſcreet practitione may ſometimes think proper, eſpecially if the eye appear blood-ſhot; or the countenance intenſel red, to diſburthen the brain, by taking away 4 o 5 ounces of blood from the temporal artery o jugular vein, carefully watching its effects, an regulating the quantity accordingly.

But however urgent the indication for bleedin may appear, it will perhaps never be prudent t hazard a larger evacuation, much leſs, a repetitio of it, at leaſt, till the powers of the ſyſtem are r eſtabliſhed, when the nature of the ſymptoms wi more clearly point out the propriety or impropri ty of the operation.

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The reports of the Humane Society, for the Year 1785, exhibit, indeed, numerous inſtances of adventurous practitioners having had recourſe to the lancet, ſometimes even more than once, during the general proceſs, and yet (if the caſes be fairly ſtated) the ſucceſs ſeemed to juſtify the boldneſs of the practice! But is it neceſſary to remind them, that ſucceſs is, by no means, a certain criterion of the propriety of a particular remedy, eſpecially, where others of a leſs doubtful nature are uſed at the ſame time? Or, that Nature, in this, as in other critical ſituations, ſometimes happily triumphs over the *remedy*, as well as the *diſeaſe?* Otherwiſe, how can we account for the number of miraculous cures and hair-breadth eſcapes, ſo frequently attributed to ſome of the moſt inſignificant, if not, injudicious means? —At all events, ſince bleeding, in the article of apparent death, can have no direct tendency to reſtore reſpiration, or invigorate vital action, but the contrary; its uſe ought, perhaps, to be reſtricted to the particular circumſtances above-mentioned; and even there, as our judicious Regiſter, Dr. Hawes wiſely admoniſhes, ſhould never be ventured upon without the utmoſt circumſpection. Accordingly, the Medical Committee, in March, 1781, "conſidered it as their duty to enter, in the moſt public manner, their CAVEAT againſt the indiſcriminate uſe of the lancet, in the various kinds of ſuffocation." *

Emetics.

42. That emetics ſuddenly weaken the powers of life is manifeſt from the ſickneſs, feebleneſs of pulſe, and general debility, which conſtantly accompany their operation—Effects, which probably overbalance any advantage that otherwiſe might accrue from the general concuſſion. Emetics therefore, but ill ſuit with the intention of reſtoring animation.

Nor can theſe, or other evacuants have any place in the treatment, at leaſt, until reſpiratio be renewed, and then happily they are ſeldo wanted, unleſs an immoderate ingurgitation o food or ſtrong liquors, previous to the acciden ſhould have rendered them neceſſary. Independent of this, however, emetics are ſtill not witho their advocates, in vital ſuſpenſion. Can this b becauſe a few drowned perſons have fortunate happened to ſurvive their ſickening operation, i addition to the danger incurred from the wate element?

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* See Tranſ. of the Royal Humane Society. Vol. 1. p. 105. A Work highly intereſting to the Medical Practitioner, and w thy the peruſal of every humane Reader.

Stimulan

Stimulants.

43. The action of ſtimulating medicines preſuppoſes the preſence of ſenſibility or irritability, in the parts to which they are applied.

As all the impreſſions upon our organs of ſenſe are communicated through the medium of the nerves, no motion or ſenſation can be excited in parts deprived of nervous energy, or muſcular irritability: hence, neither bliſters, ſinapiſms, nor even the potential cautery can produce any ſenſible effect on the dead body.

In caſes of apparent death, however, theſe faculties though ſeemingly deſtroyed, are only ſuſpended, as in torpid animals; and may, therefore, frequently be again rouſed into action, by a judicious application of proper ſtimuli.

Of the ſtimulants employed on thoſe occaſions, ſome act directly on the vital organs concerned; others, indirectly, or through the organs of ſenſe. The former are adminiſtered, with an eye to the proximate cauſe; the latter, to that of nervous ſympathy, the effects of which we often behold, but cannot explain. The former, therefore, claim our firſt conſideration.

Artificial Reſpiration.

44. Whoever conſiders the effects of air on breathing animals (13—14); their inſtinctive mo-

tions for renewing reſpiration when ſuſpended; and the impoſſibility of recovery till this be effected (19—40), will be convinced of the importance of inflating the lungs.

For the air in reſpiration is the natural ſtimulus, which not only expands that organ, and promotes a free circulation; but imparts vital heat and irritability to the whole frame (21—30).

Hence, pure air is to the lungs, what nouriſhing food is to the ſtomach; but, with this difference, that a man can live many days without food, but not many minutes without air.

Therefore, in every caſe of vital ſuſpenſion, the PRIMARY OBJECT is to inſtitute ARTIFICIAL RESPIRATION, till the NATURAL BREATHING can be re-eſtabliſhed. The propriety of this being generally allowed, various methods have been invented to accompliſh it, though by differen means. Thoſe, who attribute the efficacy of thi proceſs to the mere mechanical expanſion of th lungs, regard not the quality of the air; nay ſom even contend, that air blown from the lungs of healthy perſon is better adapted to the weak ſtat of the vital powers, than any other ſort. Othe deny that air, already vitiated by reſpiration ca be fit for the purpoſe (to ſay nothing of the apparent indelicacy of the operation), and therefo juſtly prefer atmoſpheric air.

Having formerly recommended vital air in pr

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ference to the other two, not only from theory, but actual experiment on ſome of the ſmaller animals,* its ſuperiority has ſince been confirmed by many reſpectable writers both at home and abroad.

Nor is this to be wondered at, ſeeing it poſſeſſes every neceſſary quality of common air, in a ſupereminent degree, and is alone capable of producing that chemical change in the blood, upon which vital heat and irritability depend (31). For during the ſuſpenſion of reſpiration, agreeable to what has been hinted, the blood loſes its florid colour, from being deprived of the vital part of the atmoſphere. The animal heat alſo is ſuddenly diminiſhed, and the action of the heart grows weaker every moment, till at length it ceaſes.

That curious aquatic creature, the rotillus or wheel inſect, is perhaps, of all others, the moſt tenacious of irritability. Long after it has appeared to be dead, and even ſhrivelled, it may ſtill be reſtored to life, by only dipping it in water, and expoſing it, while moiſt, to the rays of the ſun. The reaſon of which ſeems to be this: the ſun decompoſes the water, and the vital air being evolved, gradually renews the latent principle of irritability; becauſe unleſs the inſect be previouſly moiſtened with water, it cannot be revived.

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* Hints on Animation. p. 17—98.

The feeble ſtate of life then, inſtead of being an objection to the uſe of vital air, is rather a proof of its being indiſpenſably neceſſary.

In the act of drowning, though ſuffocation generally takes place after a full expiration, yet it has been computed, that from 50 to 100 cubic inches of air ſtill remain in the cells of the wind-pipe. Though this ſtagnant air muſt be highly vitiated, and therefore injurious to life, yet it cannot be evacuated by preſſure, much leſs meliorated by ſimilar air conveyed from another perſon's lungs; but may, nevertheleſs, be corrected by atmoſpheric air, and completely reſtored by vital air.

The ingenious Abbe Fontana, in attempting to reſpire pure inflammable air obtained from iron, had nearly fallen a victim to his curioſity. On the ſecond inſpiration, his countenance was obſerved to become ſuddenly pale—On the third, he fell down motionleſs. Being now removed by the aſſiſtants into the open air, he at length happily recovered.

Carbonic and azotic airs, when pure, are ſtill more ſuddenly fatal than the inflammable; yet may either of theſe be reſpired ſeveral minutes without much danger, when diluted with little more than an equal part of atmoſpheric, or even one fourth of vital air.

On the whole, it ſeems reaſonable to conclude, that in the treatment of perſons ſuffocated by the various kinds of noxious air; reſpired air muſt be leſs proper than atmoſpheric, atmoſpheric, than vital; and that could the latter be as eaſily and cheaply procured as the two former, few perſons could heſitate a moment in determining which of them they ought to prefer. Whence is it then, that the uſe of vital air has hitherto been with-held from the human ſpecies, and confined to a few experiments on brute animals? Becauſe it is even yet but little known; and its virtues ſtill leſs underſtood—A remedy rarely to be had when moſt wanted, and never without ſome trouble and expence.

It might, however, be procured on moderate erms from common nitre, which yields it in very onſiderable quantity—an article, unleſs in time f war, generally to be obtained remarkably cheap. Iow many thouſand tons of nitre has Europe conumed of late, in making gun-powder, and that with e avowed intention of DESTROYING thouſands of s inhabitants! Might not a ſmall portion be pared for *another* purpoſe, at *leaſt* equally huane and laudable, viz. that of PRESERVING a emnant of our unfortunate fellow-creatures!

Is it not ſingularly curious, that a ſubſtance of ch very humble pretenſions as common nitre (or *lt-petre*) ſhould poſſeſs properties on which ngs the fate of the moſt powerful empires! ſince by chemiſtry, it may either be converted into a fulminating engine, to overturn fortified cities, or to enable the garriſon to launch out death and deſtruction on the beſiegers! Or, that by a different proceſs, it may be made to pour forth vital air—that VIVIFYING FLUID diffuſed through the atmoſphere, which breathes in the zephyrs, which whiſpers in the breeze,* and which cheers and ſupports all animated Nature!

It has been computed by the Abbe Fontana, that a pound of nitre, calcined in a cloſe veſſel, yields about 12,000 cubic inches of vital air—a quantity ſufficient for a perſon to breathe more than 24 hours. As this air does not unite with water, it might be kept in large glaſs jars inverted in a proper tub of water, like any other air uſed in philoſophical experiments; or were it made to reſt on a ſurface of lime-water, it would be equally ſecured, and its purity might be preſerved fo a great length of time. This might prove an important addition to the apparatus of our Human Society's receiving houſes, where it might b kept in readineſs againſt emergencies, and managed with equal facility as common air. There, alſo might its comparative merit be determined b deciſive experiments.

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* *That* Vital Breeze, *which* NATURE *pours to ſave,*
The breathleſs victim, from th'untimely grave!

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Remarks on the Operation of inflating the Lungs.

45. The operation of inflating the lungs completely, demands conſiderable addreſs; and as it conſtitutes the moſt important part of the proceſs, it were to be wiſhed, that not only medical Pupils of all denominations, but alſo ſome other intelligent perſons, in every pariſh, were fully inſtructed how to perform it with dexterity—A circumſtance of no ſmall conſequence, eſpecially in country-places remote from medical aid. The operation may be tolerably performed, by the common people, by only inſerting the pipe of a pair of bellows into one noſtril, while the mouth and oppoſite noſtril are cloſed by an aſſiſtant, and the wind-pipe gently preſſed back; Then by forcing air into the lungs, and alternately expelling it by preſſing the cheſt, reſpiration may be imitated. In want of bellows, air may be blown through a tobacco-pipe, a quill, a pencil-caſe, or even a card folded into the form of a tube.

The little portion of water, which is ſometimes imbibed in the act of drowning, though too ſmall to occaſion death, may yet retard recovery, by interrupting the paſſage of the air into the extreme cells of the wind-pipe. Hence, probably, the adjacent column of blood cannot ſo readily receive the beneficial change neceſſary to renew heat and motion. Though the water cannot with ſafety be extracted by the exhauſting ſyringe; yet by repeated inſpirations and alternate expirations, it may in the courſe of the proceſs, be gradually diſſipated and diſcharged in form of aqueous froth.

But the main obſtacle to this operation is, the conſtrictive power, by which (in the article of drowning), the aperture of the wind-pipe is ſometimes obſtinately ſhut up. During this obſtruction, inflation by the mouth or noſtrils, though the wind-pipe be preſſed back in the uſual way, cannot ſucceed. For the air, inſtead of entering the lungs, will find readier admiſſion into the ſtomach: by which the latter will be diſtended; the capacity of the cheſt diminiſhed; and the action of the lungs impeded. Hence may be underſtood, why unexperienced practitioners are ſo often baffled in attempting to perform this operation; and why it ſometimes fails in caſes, which at firſt, ſeemed highly promiſing of ſucceſs.

In order to overcome the conſtriction of the glottis, the tongue muſt be not only depreſſed, but conſiderably drawn forward; by which means the epiglottis (the obſtructing cauſe) will be elevated, and the aperture opened (10). This difficulty being ſurmounted, the operation afterwards will generally go on without interruption. Sometimes, however, the jaw is alſo locked, by an invincible ſpaſm, when the uſual proceſs becomes totally impracticable.

Even here, the humane Practitioner rather than abandon the patient to his fate, will yet make one effort in his favor, by having immediate recourſe to Bronchotomy—an operation, which it is unneceſſary here to deſcribe. It may not, however, be improper to obſerve, that in order to prevent the inconvenience of blood entering the wind-pipe, and the danger of dividing the recurrent nerves, on which the voice materially depends, it has lately been propoſed to make a longitudinal inciſion through the integuments and thyroid cartilage, at once into the wind-pipe. How far this new method may deſerve the preference, muſt be left to future obſervation.

For the purpoſe of artificial reſpiration, various inflating machines have been contrived; ſome of a ſimple conſtruction, others more complex, as ſingle and double bellows with air-tubes annexed: ſome adapted to the noſtrils, others to the aperture of the wind-pipe.

In place of bellows, ſome have preferred an exhauſting ſyringe, conſtructed with an intention to extract water as well as air—a hazardous undertaking! For unleſs it be uſed with the utmoſt circumſpection, it may occaſionally, inſtead of water, extract blood.

In order to compriſe the whole apparatus in a very narrow compaſs, the inflating inſtrument is generally made too ſmall to anſwer the intention

completely.

completely. For unleſs it be capable of containing a proper quantity of air for a full inſpiration, it cannot ſufficiently expand the lungs, or communicate a due proportion of aerial influence to the blood. To effect which (in the manner, in which it is commonly performed), would probably require at leaſt two inſpirations for one expiration. But the quantity of air neceſſary for one inſpiration, having not yet been determined, an indefinite quantity is thrown in, and the operation, of courſe, is conducted without much preciſion.

While one practitioner judges 12 cubic inches to be ſufficient, another alleges that 100 are ſcarcely enough; while a third (Mr. Kite) declares that the lungs are capable of containing at leaſt 300, and conſequently, that this quantity would not be too much. In another paſſage, however, he obſerves, "a man uſually inſpires 17 cubic inches, but after expiration there remain in the lungs 87!" Again; that as "animals die in the act of perfect expiration, *no* air can be even ſqueezed from their lungs." Whence he concludes that, "in caſes of ſuſpended reſpiration, no bad effects can enſue from noxious air ſtagnating in the cells of the wind-pipe." How ſhall we reconcile the above paſſages with one another, or with the following one, which affirms, "that no ſooner is noxious air inſpired even by a healthy perſon, than it induces a *palſy* on that exquiſitely ſenſible membrane, which lines the orifice of the wind-pipe?"

After the laſt expiration in drowning, there remain, according to a late calculation, at leaſt 109 cubic inches of air in the lungs, which probably is near the truth. Now admitting this, which appears to be a moderate computation, might not the forcible addition of 300 more, amounting in the whole to 409 cubic inches, endanger a fatal laceration in an organ of ſuch exquiſitely tender fabric?

At a moderate natural expiration, it has been found by Fontana, that 35 inches are expelled, and that in a forcible one, about double that quantity. But ſince a conſiderable portion of the air is conſumed in the act of reſpiration, the quantity expired muſt ever fall ſhort of that which was inſpired (15).

On the whole, though it may be difficult, and perhaps not abſolutely neceſſary to adjuſt the proper ſtandard with exactneſs; yet it would be deſirable, that a certain medium ſhould be ſtruck out between ſuch oppoſite extremes: denoting ſuch a quantity, for example, as might be quite ſufficient on one hand, moderately to expand the reſpiratory organ through all its ramifications; on the other, to guard it againſt too great force, or over-diſtention.

Inſtead of 12 cubic inches, which ſeem evidently too little, or 300, which appear abundantly too much; we venture to propoſe 112, as more nearly approximating the deſired medium. Accordingly, the inflator, whether bellows or ſyringe, ſhould be made to contain juſt this quantity, to be thrown in at each inſpiration, and ſuffered to remain about 15 ſeconds, when it may be expelled by a full expiration. Theſe alternate motions ſhould be continued till natural reſpiration commences, or repeated at intervals, during the ſpace of 3 hours, or till all hopes are vaniſhed.

This operation, properly conducted, evidently tends to expedite the paſſage of the blood through the lungs, and remove congeſtion; far beyond what could poſſibly be effected by bleeding; admitting even that the latter could be undertaken with propriety.

Electricity.

46. Electricity preſents us with one of the moſt ſpeedy and powerful ſtimulants hitherto diſcovered, which like other active remedies, may prove ſalutary or injurious, according as it is managed. Applied in a moderate degree, it excites vital action after other ſtimuli have ceaſed to act: carried to an extreme, it deſtroys irritability, and life itſelf.

ſelf. For whether the ſtroke be ſent from a thunder-cloud, or a highly charged electrical battery, is immaterial; the effect from either may alike prove fatal. Hence, the impropriety of thoſe violent ſhocks of electricity formerly given in palſies, which like other exhauſting ſtimuli not only defeat the intention, but prove extremely injurious. While moſt other ſtimulants affect the internal organs only by ſympathy through the ſtomach, this at once, penetrates the heart, and pervades the inmoſt receſſes of the frame. Hence in the torpid ſtate of apparent death, it ſeems admirably calculated to rouſe the dormant powers. If to theſe well known effects of electricity, we add what has been ſuggeſted concerning the probability of its being the principal agent in the action of the brain and nerves (33—35); it will, on the preſent occaſion, ſtill further claim our attention. For till the intercourſe between the voluntary and involuntary powers can be reſtored, there can be no hopes of perfect recovery.

The effects of electricity were, ſometime ago, finely illuſtrated by the ingenious Abildgard, in many curious experiments on apparently dead animals; wherein by a dextrous management of its power, he is ſaid to have been capable of alternately ſuſpending and reſtoring animation at pleaſure. Theſe experiments have ſince been repeated by an eminent electrician in London, and with nearly ſimilar effects. On ſmart ſhocks being paſſed through the head, the animal immediately became motionleſs: on tranſmitting gentle ſhocks through the region of the heart, oſcillations of the external muſcles inſtantly enſued. When the operation was ſuſpended for ſome minutes, or its direction altered to more remote parts; the animal relapſed into its quieſcent ſtate, and conſtantly revived on its being repeated as at firſt. What ſeemed worthy of attention, the vital organs were more certainly excited, and more vivid motions produced by ſlight, than by rougher ſhocks; the latter appearing to retard, rather than promote recovery.

Whether the operation was performed on a large turkey, or a ſmall quadruped, the reſult was the ſame. On drowned animals, however, it often failed, eſpecially in the younger ſort, the principle of life in them, being very feeble.

From the above phenomena, which appear to be no leſs ſingular than intereſting, it ſeems reaſonable to conclude, that electricity ought to be principally directed to the thoracic viſcera in form of gentle ſhocks: That theſe ſhould be ſo accurately adjuſted to the *tone* of the moving fibres, as may renew that perfect uniſon of action, which is natural to the ſyſtem (31—35); the due medium of which, however, can only be diſcovered by attentive obſervation.

Hence, perhaps, the ſurpriſing ſucceſs of electricity in ſome caſes that appeared deſperate; and its failure in others, after it had produced ſome flattering tokens of recovery. Inſtances of both which are to be met with in the Reports of the Humane Society, for the Years 1787 and 89.

It has been found, by the experienced electrician lately mentioned, to afford preſent relief in ſyncope, brought on by violent excitement—by ſudden emotions of mind—and even by the ſtroke of lightning. Thus may electricity, when managed with addreſs, be converted into a remedy to counteract its own exceſſes. Nor is this to be wondered at, ſeeing its effects may be ſo greatly diverſified according to the different modes of application, by which its powers are adjuſted. Thus it may be directed to paſs ſilently along the metallic wire; to melt it inſtantly; or diſperſe it with incredible fury. Thus a violent blaſt of air extinguiſhes the burning taper, while a gentle breeze re-kindles it. In like manner, the tickling the ſoles of an infant cauſes convulſive laughter; while moderate rubbing produces no viſible emotion.

From ſuch remarkable effects produced from apparently ſlight cauſes, and from the vaſt diſproportion between the degree of ſtimulus and the motion excited; we learn, why an animal under a ſtate of torpor, or apparent death, is more ſpeedily reſtored by gentle vibrations, than by violent ſhocks.

If electricity be one of the moſt probable means of renewing vital action, agreeably to what was firſt hinted in 1783;* it certainly ought to conſtitute an early part of the proceſs. A late writer, however, peremptorily aſſerts, that to "ſtimulate the heart by the electrical ſhock, without firſt removing the obſtruction of collapſe, is one of the moſt ill-judged, and moſt dangerous plans of recovery; and that it is abſolutely taking away life."

How came it then, in the experiments related by Dr. Abildgard, and the ſucceſsful caſes already cited (to which others might be added) that electricity did not prove fatal? In them, it neither appears, that the lungs were previouſly inflated, or any attention paid to the collapſe: Yet electricity alone, that "ill-judged, dangerous remedy," inſtead of "taking away life," we find, abſolutely reſtored it.

If under ſuch diſadvantages, it ſucceeded beyond expectation, it ſeems evident that electricity is not ſo dangerous in the firſt inſtance, as he ſeems to imagine; that, on the contrary, it may be uſed with perfect ſafety, during any part of the proceſs. That artificial reſpiration, however, may contribute not a little to its ſucceſs, can ſcarcely be doubted. Therefore to make them co-operate, their forces muſt be combined, or employed in ſucceſſion.

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* Hints on Animation.

Here, the Reader will pleaſe to recollect, that in ſuſpended reſpiration, the lungs, inſtead of being alternately expanded and contracted, are now entirely at reſt.

That the blood, inſtead of circulating with velocity, to the remoteſt parts of the body, is arreſted in its paſſage through the lungs: Inſtead of purſuing its courſe through the arteries, lingers in the larger veins, as in torpid animals: Inſtead of being continually renovated with freſh air, is now wholly deprived of its influence.

That the heart in like manner, inſtead of repeating 70 or 80 briſk pulſations in a minute, now probably does not perform above 10 or 12, and thoſe extremely feeble ones. Hence, while theſe important functions are ſuſpended, all the other operations dependent on them, muſt alſo neceſſarily ceaſe.

Theſe, and the preceding obſervations (39—44) point out the two leading circumſtances, which demand the firſt attention; viz.

The lungs muſt be repleniſhed with freſh air, and the heart enabled to propel the blood to the left ventricle.

The former is to be effected by inflating the lungs: the latter, by exciting the action of the heart.

Now, it is known from various obſervations, that the blood paſſes moſt freely through the pulmonary veſſels, when the lungs are expanded by a full inſpiration. If at this juncture, the heart can be excited to exert its powers, while the reſiſtance is ſo conſiderably diminiſhed; it muſt more eaſily propel the blood forward, when part of it will enter the left cavity now almoſt empty. This being brought into action, will, in its turn, urge it forward into the arterial ſyſtem.

Here, electricity then ſeems perfectly adapted to co-operate with artificial reſpiration in expediting the proceſs: being known not only to promote the progreſſive motion of fluids in capillary tubes, but alſo the circulation of the blood in animals (36).

As ſoon as the lungs therefore are fully expanded with air (and the more *pure* this is, undoubtedly the better), at that moment, let the heart be excited by a gentle electrical ſhock, paſſed obliquely from the right ſide of the cheſt through the left, in the direct courſe of the heart, and pulmonary veſſels. Let the lungs be now emptied of the air, and again expanded, when another ſhock may be given. The heart being thus excited into action, the dark blood, loitering near its right cavity, will begin to move forward, and to reſume a more florid colour. This being gradually renovated, will renew the action of the left ventricle, when the circulation will alſo be ſpeedily reſtored, and that perhaps, with more certainty and expedition, than by the uſual mode of conducting the operation.

The longer reſpiration has been ſuſpended, and the more the vital powers are enfeebled, the more gentle ought to be the means of reſtoration. In which caſe, it may be prudent to begin with moderate vibrations, or very ſlight ſhocks; * and inſtead of repeating them at every inſpiration, to poſtpone them to every ſecond or third ſucceſſive expanſion of the lungs. For it will be ſafer to keep pace with the ſlow and languid movements of the heart, than to waſte the ſmall remains of irritability in fruitleſs exertions.

The courſe of the electric circuit may be alſo properly varied, directing it alternately from right to left, and from left to right; particularly through

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* By placing the Electrometer at firſt only a quarter of an inch from the coated jar, and by gradually increaſing the diſtance, if no ſenſible effect be produced.

It can ſcarcely be neceſſary to remark, that the diſcharging ods muſt be *inſulated*, otherwiſe ſhocks may inadvertently be ommunicated to the operator.

thoſe parts that are known to retain irritability the longeſt; as the heart, the diaphragm, and alimentary canal.

Gentle ſhocks may alſo, at intervals, be tranſmitted along the whole courſe of the ſpine.

Some prefer negative electricity, as affording a more poignant ſtimulus than the poſitive, in conſequence of the electrical fire being obſerved to iſſue *from* the body in converging rays, as from a point; while in the poſitive, it is preſented *to* the body, in a pencil of diverging rays, by which its action is thought to be weakened. The difference however, it is preſumed, cannot be very great.

In drowned ſubjects, the body muſt firſt be well dried; otherwiſe the moiſture may carry off a great part of the electrical fluid, and ſo defeat the intention; as appears ſometimes to have happened, not only in experiments on animals, but alſo on the human ſpecies. Where electrization by ſparks, inſtead of ſhocks, is preferred; the body ought always to be completely inſulated.

" Electricity," ſays that experienced Practitioner Mr. Kite, " has, in every inſtance that has been made public, proved its importance, and afforded the moſt ample and deciſive teſtimony of its wonderful and extenſive influence, even in caſes where it failed of producing the deſired effect."

To this he ſubjoins the following account of a drowned perſon, on whom the uſual means, though employed near an hour, did not produce the leaſt benefit or alteration.

"Electricity was then applied, and ſhocks were tranſmitted in all directions. The muſcles, through which the fluid paſſed, were thrown into contractions, nearly as *ſtrong* as are uſually obſerved in *healthy* people: This extraordinary appearance recurred, as often as electricity was applied, for the ſpace of 2 *hours;* after which period, its effect ceaſed, and *no* alteration whatever *could* be produced. Since this," he adds, that he "has conſtantly had recourſe to it in ſimilar ccidents, and generally with the ſame effect. But when life is *wholly* extinguiſhed, *not* the leaſt *motion* whatever can be produced by electricity."

In our Society's Reports, there occurs a ſtill more affecting inſtance of the ſame kind; where, e are told, "the electrical ſhock was tried in e caſe of James Lawſon, 4 *hours* after he was ken out of the water. The firſt ſhock excited *pulſation* in the temporal artery: The next dif- ſed a *florid* colour over the face, and occaſion- the *blood* to flow in a *copious* ſtream from an

orifice

orifice in the jugular vein, which had been opened in the beginning of the proceſs *without a drop* having iſſued from it. The *ſubſequent* ſhocks were attended with *no* manifeſt advantage, and every favorable ſymptom ſubſided!"

Had electricity, in the preceding caſes, been made to co-operate with artificial reſpiration, or had its ſtimulating power been regulated in the manner we have juſt propoſed; the event (at leaſt, if we may be allowed to judge from actual experiments on animals) might probably have proved more favorable.

During vital ſuſpenſion, irritability muſt be conſiderably accumulated, till at length the exceſs proves fatal—Hence the neceſſity of artificial ſtimuli, to compenſate for the defect of the natural ones, in carrying off the redundancy. But i theſe are too powerful, or too long continued they may prove equally deſtructive, by totally exhauſting the moving fibres (31). Thus may the ſalutary efforts of Nature be overpowered by the officiouſneſs of Art—a circumſtance, which ſometimes we have had occaſion to obſerve with regret.

Heat.

47. Heat is ſo eſſential to life, that without certain degree of it, neither animals, nor eve

vegetable

vegetables could ſubſiſt. The eggs of oviparous animals, the ſeeds of vegetables, and growing plants diſcover, by the thermometer applied to their internal parts, a degree of temperature evidently exceeding that of the circumambient atmoſphere. Heat accompanies the embryo from the earlieſt period to the laſt ſtage of its exiſtence, and therefore has been conſidered by ſome as the ſource of vitality. Hence, the fecundated egg brings forth in due ſeaſon, whether the proper degree of heat be communicated by incubation, or by the temperature of a well regulated oven.* Hence alſo, the myriads of animated beings, which, from imperceptible ova, are uſhered into exiſtence, by the ſummer's ſun! Hence, dormant animals are rouſed from a torpid ſtate, by the vernal warmth; and hence too, drowned perſons have ſometimes been re-animated by the ſolar rays.

From theſe, and ſimilar conſiderations, it was very natural to conclude, that to reſtore heat to the body, muſt be one of the moſt powerful means of reſtoring animation. Accordingly, it has hitherto been generally attempted, by the application of artificial heat; under an idea, that until this could be accompliſhed, every other method would prove ineffectual: Without conſidering perhaps, that an inanimate ſubſtance of ſuch a bulk as the human body, containing a large quantity of matter under a ſmall ſurface, muſt acquire heat very ſlowly: That to accompliſh this in the internal parts (were it even practicable with ſafety), would demand great length of time, during which, other meaſures no leſs eſſential muſt be poſtponed.—Widely different is the proceſs by which Nature preſerves the human heat of an even temperature (20). Whenever this is ſuddenly varied, the vital actions are proportionably exerted to reſtore the equilibrium. It is very obſervable, that life is more endangered when the heat is raiſed by any means 6 or 8 degrees above the natural ſtandard, than when it is reduced 18 or even 20 below it. Hence, perhaps, it is, that the ſyſtem is endowed with two powers of reſiſting heat, and but one of generating it (20).

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* By the application of electricity, incubation is ſo remarkably accelerated, that chickens are ſaid to have been hatched in about 48 hours. Mem. de l'Acad. de Berlin. 1778.

When reſpiration ceaſes in a drowned animal, the power of generating heat is ſuſpended, and the body gradually loſes the remains of its natural warmth; till at length it is reduced to the temperature of the ſurrounding medium.

During this, if we attempt to raiſe the heat ſuddenly to the natural ſtandard, we exhauſt the feeble remains of life. Nay, although we apply artificial heat by ſlow degrees, yet ſtill if no other means are uſed, it commonly fails of ſucceſs. But if we firſt have recourſe to artificial reſpiration, in the manner already deſcribed (45), the experiment generally ſucceeds better, producing the deſired effect.

The lungs being thus ſupplied with air, the blood is again rendered fit to receive a freſh ſupply of latent heat, and to diffuſe it, in a ſenſible form through innumerable arteries and veins, from the centre to the circumference (19). Thus is the natural heat reſtored, and communicated to every part of the ſyſtem, with more certainty and expedition, than by any external means that can be deviſed.

The moſt efficacious method of reſtoring heat then, is to renew the generating power, by renewing reſpiration. For, till this natural proceſs can be re-eſtabliſhed, all that can be reaſonably expected from the application of artificial heat, is to prevent the natural heat from being conveyed off; and to preſerve ſenſibility and irritability, till the generating power can be renewed, on which they ſo intimately depend (19). Even in this view, it is a matter of conſiderable importance, and demands no ſmall attention in the management.

To conduct it with propriety, the degree of heat ought to be regulated by the internal heat of the body, and the remaining powers of life. Applied indiſcriminately, it cannot but be productive of miſchievous conſequences.

In caſes of ſuffocation from noxious air, the body retains a greater degree of warmth than natural, even many hours after death. To accidents of this nature, the Ruſſians are frequently expoſed, during the cold ſeaſon, from the noxious air of their ſtoves, and want of due ventilation.

As ſoon as a perſon is diſcovered to be thus deprived of ſenſe and motion, he is ſtripped naked, and brought into the open air; where he is rubbed with ſnow, or cold water is daſhed repeatedly over the whole ſurface of his body.

At firſt, the animal heat is ſenſibly increaſed, but by continuing the cooling proceſs, it is at length reduced ſomewhat below the natural ſtandard, when ſigns of life begin to appear.

This method, we are informed, is univerſally practiſed among the common people, and with conſtant ſucceſs, where reſpiration has not been ſuſpended more than an hour.

It, perhaps, firſt originated from the ancient and well known experiment of ſuffocating dogs and other animals, in the mephitic air of the '*Grotto del Cani*,' where it is often performed to gratify the curioſity of travellers.

When the apparently dead animal is plunged repeatedly into the cold water of the adjacent lake, it is obſerved to recover much ſooner, than when only removed into the open air.

But what is ſtill more remarkable in the Ruſſian practice, is, that where the ſymptoms are brought on by extreme cold, from periſhing in the ſnow; and where the heat of the body, inſtead of being above the ſtandard, is reduced almoſt to the point of congelation, yet the ſame method is purſued, and with the like happy ſucceſs.

The ſame cuſtom alſo obtains in other cold climates, where the rude inhabitants, taught by long experience to avoid the application of heat to frozen bodies, have diſcovered the ſuperior efficacy of cold, and how to employ it, either to increaſe or diminiſh vital heat, and ſo correct its own exceſſes—a knowledge, which might do credit to the ingenuity of the more enlightened nations—a practice, that might not be unworthy of their imitation.

But thoſe, who have long been in the habit of applying artificial heat; whether the accident happens in winter or in ſummer; whether the ſufferer is drowned under the ice, or ſuffocated by inflammable air; bleached by the drifted ſnow, or ſcorched by lightning; will doubtleſs conſider it as prepoſterous folly, thus to attempt to reſtore loſt heat, by the application of cold water or ſnow! or to make the ſame remedy anſwer intentions ſo diametrically oppoſite! How ſhall we reconcile this paradox?—The application of cold acts firſt as a ſtimulus, and if long continued, as a ſedative: hence rubbing with ſnow, at firſt increaſes the heat of the ſyſtem; afterwards, begins to diminiſh it.

If a perſon, benumbed with extreme cold, ſuddenly expoſes his hands to a hot fire; a tingling pain is felt, but the cold numbneſs continues. If, inſtead of this, he immerſes his hands in ſpring-water, though only a ſmall degree warmer than the external air, or rubs his hands with ſnow, a pleaſing ſenſe of warmth enſues, and the numbneſs vaniſhes.

When Mr. Hunter expoſed a dormouſe to the intenſe cold of 20 degrees, its natural heat, inſtead of being greatly diminiſhed as might have been expected, ſuddenly roſe 12 degrees.

Where the temperature of the body is conſiderably reduced, a ſmall degree of additional heat may produce powerful effects. Thus dormant animals become torpid in a temperature of 40; a moderate degree of additional heat revives them, a greater deſtroys them (39).

Thus Nature inſtructs us that the artificial heat employed in reſtoring animation, ought to be very moderate; and the more ſo, in proportion as the natural heat is diminiſhed.

At the beginning of the proceſs, the degree of heat ſubſiſting in the internal parts ought firſt to be aſcertained, by introducing a ſmall thermometer into the back part of the throat, or under the tongue. Should the temperature be found equal, or even ſuperior to that of health, as ſometimes happens; there certainly can be no pretence for the addition of artificial heat, which would be wholly ſuperfluous. Inſtead of which, the natural heat ought probably to be ſomewhat reduced, according to the cooling plan juſt mentioned. If, on the other hand, the internal temperature of the body ſhould ſeem to be reduced to the loweſt ebb, and the external parts apparently frozen; the application of artificial heat would ſoon prove deſtructive, and therefore the cooling method ought in the beginning, to be rigorouſly purſued.

If, at the higheſt pitch of temperature then, as well as at the loweſt, the application of ſnow, or cold water affords a more ſafe and efficacious ſtimulus than artificial heat, is there not ſome reaſon to ſuſpect, that the cooling method might alſo prove preferable, at all the intermediate degrees? That in drowning, for inſtance, where the temperature of the body, through expoſure to extreme cold, is often reduced many degrees below the ſtandard, might not a momentary application of this method, at the beginning of the proceſs, prove more ſalutary, than that ſudden tranſition to artificial heat adopted by modern practitioners?

Should it fail, after a few minutes trial, of producing any ſign of re-action in the ſyſtem, the application of a gentle degree of heat ſhould next be had recourſe to; for every change of temperature acts as a ſtimulus. Beginning, therefore, at the low degree of 40, it might be gradually raiſed to 70; but, perhaps, ought rarely to exceed the tepid warmth of 80.

For till the generating power can be reſtored, in vain may we attempt, by this, or any other means to raiſe the heat of the body to the natural ſtandard. Yet ſtill artificial heat is a matter of conſequence, in preſerving the remains of natural heat, and in cheriſhing ſenſibility.

Various methods have been contrived for communicating heat; and many of them, could they be had in readineſs, might, under proper management, be employed with advantage. Such as the immerſing the body in warm aſhes or ſand: The wrapping it in the ſkin of an animal juſt killed; or the paſſing a warming-pan over it, while covered with flannel: The placing it in a warm bed, between 2 perſons in health; or before a fire: Or, finally, expoſing it, when the weather is favourable, to the rays of the ſun. All of which, however, are liable to certain inconveniences; the indefinite degree of heat which they communicate is too fluctuating; ſometimes too little, often too great.

They generally occaſion loſs of time; and all except the laſt, conſiderably interfere with the more important proceſs of artificial reſpiration.

A tepid bath affords the moſt uniform degree of warmth; and is, perhaps, the moſt manageable: but where it cannot be immediately had, bladders of tepid water, or flannels wrung out of the ſame, may in ſome meaſure ſupply its place. Theſe may be applied to the region of the ſtomach; to the arm-pits; and to the extremities: their warmth being retained by a covering of warm flannel.

It is ſcarcely neceſſary to repeat, that the internal heat of the body ſhould more than once during the proceſs be examined by the thermometer, and its variations carefully noted. The room ought to be well ventilated, and its heat temperate; viz. between 56 and 64 degrees of Fahrenheit's ſcale.

If irritability keeps pace with animal heat, inſomuch that with a very few exceptions, both forſake the human frame at the ſame moment; then will the degree of internal heat, marked at intervals, by the thermometer, determine the degree of irritability, while any remains; and, conſequently, afford a NEW TEST of the PRESENCE or ABSENCE of LIFE.

Nor does that heat, which, in certain diſeaſes, is generated in conſequence of the putrefactive fermentation, and which often ſubſiſts many hours after death, affect the preſent queſtion, which reſpects recent accidents in a ſound ſtate of body only.

Agitation of the Body.

48. Briſk agitation is beſt performed between two people; one taking hold of the patient's feet, while the other ſupports the ſhoulders, with the head properly elevated.

This has alſo been lately ſuſpected of having a dangerous tendency, though apparently without any juſt cauſe. It certainly affords a ſafe and ſpeedy mechanical ſtimulus to the whole machine, and may be executed in leſs than 3 minutes; producing all the advantages that could be hoped for from the action of an emetic, and without the danger.

The ſucceſſive concuſſions thus communicated to the heart and internal organs, tend to put the ſtagnant blood in motion; to renew oſcillations in the moving fibres; and to incite the hidden ſprings of life into action.

A remarkable inſtance of which accidentally occurred, ſome years ago, at a funeral proceſſion, where a ſudden jolt of the hearſe, is ſaid, to have diſturbed the repoſe of the apparently dead Lady within; who, to the ſurpriſe of the attendants, and utter confuſion of her huſband, inſtantly gave a piercing ſhriek! This, being repeated in her uſual ſhrill and well known key, left him no room to doubt of his *cara ſpoſa* being ſtill actually alive. It therefore obliged him, though very reluctantly, to put an end to the ſepulchral ceremonies, and releaſe the ſuppoſed corpſe; who, it is added, lived many years after, till at laſt ſhe had the ſatisfaction of ſeeing her huſband "peaceably inurned" near the very ſame ſpot.

By briſk agitation, ſtill-born children have ſometimes alſo been unexpectedly brought to life. Sometimes drowned perſons have been reſtored by the ſame means.

Being a ſimple and harmleſs effort to reſtore animation, and eaſily performed by the lower claſs of people, it ought, by no means, to be diſcouraged. If it fails, it does no injury, unleſs it be performed with unnatural violence: If it ſucceeds, it ſuperſedes the uſe of other meaſures.

Friction.

49. Friction, with agitation of the body, was one of the earlieſt methods employed in the recovery of the drowned; and ſtill conſtitutes almoſt the only means known to the common people.

Notwithſtanding the rude, unſcientific manner, in which they generally conduct the operation, yet there are not wanting inſtances of its ſucceſs, which probably would have been more numerous, had it been directed by more ſkilful hands.

Its general effects may be underſtood, from its ſtimulating the extremities of the cutaneous nerves, which ſympathize with the principal internal organs. But ſtill more, in the preſent inſtance, from its exciting the arteries to propel the blood into the correſponding veins, and from thence forwards to the heart. The left cavity of that organ being nearly empty (2), and the valves preventing any retrograde motion in the veins, friction tends to expedite the obſtructing column in the pulmonary veſſels ſtill forward; when, if the heart lends any aſſiſtance, part of the blood muſt find its way into the left cavity, as has been already hinted (44).

The blood thus put in motion, though at preſent deprived of part of its wonted ſtimulus, cannot but affect the heart; ſince the natural action of that organ is longer ſupported by its own warm blood, than by any artificial ſtimulus applied to its external ſurface alone.

Therefore, though a ſmall portion of blood is only propelled into its left cavity by this means, yet it gradually contributes to renew the contractions of the heart.

Thus friction, without increaſing the general maſs of blood, aſſiſts in promoting its fluidity, and in diſtributing a portion of it gradually to the left ventricle, where it is moſt wanted; in this reſpect, therefore, it completely ſuperſedes that more doubtful operation, the transfuſion of the blood, which has been lately recommended.

To increaſe the efficacy of friction, it has been cuſtomary to accompany it with other ſtimulants, as common ſalt, volatile alkali, warm brandy, or other ſpirits. All which, however, are liable to inconveniences, which, perhaps, in ſome meaſure counterbalance the advantages ſuppoſed to be derived from their ſtimulating effects.

It is very certain, that the ſkin, the organ of touch, loſes its faculty of feeling in proportion as it is deprived of its natural warmth, and does not recover it again till this be reſtored. Stimulating medicines, therefore, applied to it, before it has in ſome degree recovered its warmth, muſt prove ineffectual, and in proportion as they interrupt the other meaſures, prejudicial.

Dry ſalt, applied to the ſkin, acts chiefly as a mechanical ſtimulus; while by its angular points, it generally produces troubleſome excoriations, which often degenerate into ill-conditioned ſores.

Volatile ſalts, as ſpirit of ſal volatile, or of hartſhorn, are liable to ſpeedy evaporation in proportion

to

to their volatility, and the warmth of the ſeaſon. Inſtead of exciting heat therefore as intended, they manifeſtly occaſion cold, and alſo by their pungency greatly incommode the eyes of the aſſiſtants.

Warm brandy, and other ardent ſpirits are ſubject to the ſame inconvenience of producing cold, and the more ſo from being firſt heated, becauſe this increaſes the evaporation (20).

Nor are oily liniments and embrocations, lately propoſed to obviate theſe inconveniences, entirely free from objection; becauſe, inſtead of reſtoring the ſkin to that natural degree of firmneſs and tenſion, ſo neceſſary to the tone and energy of the organ of feeling, they tend to relax and enfeeble it ſtill more. Beſides this, their fluidity renders them conductors of electricity, by which, in common with ſpirits and other liquid applications, they tend to draw off a conſiderable portion of that fluid, and to defeat the intention of ſimple electrization by ſparks, which ſome judge, though perhaps without ſufficient cauſe, to be more efficacious than ſhocks.

In order to render friction perfectly ſafe, and at the ſame time to give it its full efficacy, the following cautions may not be unneceſſary.

1st. Violent friction, in theſe caſes, is generally unneceſſary; it ſeldom can be uſeful: it often may prove hurtful. In highly plethoric habits, for example; in diſeaſed lungs; and in recent intoxication;

violent friction, in the rough manner in which it is commonly performed, may, by urging the blood too forcibly to the heart and pulmonary veſſels, before the left ventricle can have time to empty itſelf, produce a ſudden extravaſation in the lungs or brain, converting at once a hopeful ſtate of recovery, into a fatal hæmoptoë or apoplexy!

2ly. To obviate any danger that may in ſuch caſes ariſe from friction, artificial reſpiration with electricity, ought in propriety, to precede its uſe, that a free paſſage may be firſt opened through the lungs (44), when friction may be ſafely purſued with more freedom.

3ly. Where, through want of ſkilful aſſiſtants, the previous proceſs cannot be properly managed, the friction ought to be more gentle; beginning at the upper and lower extremities, where the circulation is always the ſloweſt, and proceeding gradually to the thighs, abdomen, and cheſt; where it ſhould be occaſionally ſuſpended, about half a minute at intervals, for the heart to evacuate itſelf.

4ly. Upon the whole, friction may be performed to the beſt advantage by the hands alone; the natural warmth of which will be communicated to the body, and gradually increaſed by the continued attrition. Not to mention the additional advantage that may probably accrue from its exciting at the ſame time, the NERVOUS ELECTRICITY (32).

5ly. Next to friction with the warm hand, the rubbing with a fleſh-bruſh may occaſionally be had re-

courſe

courſe to: or, what may prove ſtill more advantageous, hare-ſkins, or warm flannels, well impregnated with the penetrating fumes of gum benzoin, kept in readineſs in a ſtate of fuſion. Beſides its ſtimulating and gently bracing quality, which ſeems well adapted to the preſent purpoſe, this fragrant gum poſſeſſes a pleaſant odor, which inſtead of annoying, may prove grateful to the medical aſſiſtants, during their benevolent and truly meritorious exertions, in the cauſe of humanity.

Stimulating Cordials.

50. In no caſe of debility, whether acute or chronic, can a ſtimulating cordial be more immediately wanted, than where the vital actions are ſuddenly ſuſpended.

As the ſtomach is endowed with exquiſite ſenſibility and maintains an intimate ſympathy with the heart and brain, it certainly, on thoſe occaſions, claims particular attention.

In time of health, cordials, on being received into the ſtomach, preſently manifeſt their enlivening effects: even before they can have time to enter the lacteals, their ſtimulus is diffuſed through the remote parts of the ſyſtem. In order, therefore, to reſtore the motion of the heart, through the medium of the ſtomach, ſome active cordial ought to be early adminiſtered. This having been conſidered by the Faculty ty as unſafe, if not wholly impracticable, until the power of ſwallowing ſhould be reſtored, it has hitherto on that account, been very rarely attempted. Fortunately however, we can now with confidence aſſert, that inſtead of waiting for the return of deglutition—an event which may never happen, fluids may at the beginning, be immediately conveyed into the ſtomach, without occaſioning the ſmalleſt hazard of ſuffocation.

The inſtruments, for performing this and other parts of the proceſs, will be fully deſcribed in the Appendix.

Amongſt the claſs of internal ſtimulants, ſpirituous liquors, as rum, brandy, or uſquebaugh are well adapted, as being ſpeedy in their operation: but the ſedative effect which ſucceeds the action of theſe, and all other potent ſtimuli of the exhauſting kind, tends to limit their uſe, and demands no ſmall circumſpection.

Good wine (when it can be had), though leſs active, affords a more generous cordial, and ſeems to deſerve the preference, unleſs where it has been previouſly abuſed by the patient's habitual intemperance in that liquor. Strong wines, drank copiouſly as daily beverage, at length ceaſe to produce their exhilarating effects as cordials. Hence drunkards feel the neceſſity of gradually increaſing their wonted doſe, or changing their liquor.

When the vital powers are ſunk to a very low ebb, wine as a cordial, requires to be given in large quantity, to produce the deſired effect. Hence, in malignant fevers, attended with extreme proſtration of ſtrength, perſons remarkably abſtemious at other times, are now capable of drinking daily 2 or 3 pints of ſtrong wine, without the leaſt appearance of intoxication.

In the preſent caſe, the ſtomach being ſtill leſs ſuſceptible of ſtimuli, ſeems to require ſome other more active cordial to be added to the wine, eſpecially as the whole quantity of liquid ought probably to be limited to about a pint, for fear of too great diſtention.

To this quantity, therefore, of madeira or ſherry, might be added a dram or two of ſome warm aromatic tincture, as that of cinnamon, or lavender: or, what would afford a ſtill more active ſtimulus, half a dram of pure ſpirit of ſal ammoniac. To give this volatile ſpirit its due poignancy, it ought to be prepared from 3 parts of quick-lime to 1 of ſal ammoniac; keeping it well ſecured from the external air.

M. Sage, from various experiments, aſſures us that, by this remedy alone, after others had failed, he was enabled to reſtore birds and quadrupeds previouſly ſuffocated in noxious air.

After artificial reſpiration with electricity has been carried on about 20 minutes, this ſtimulating cordial may be found ſtill more beneficial.

As the lymphatic veſſels have been obſerved to perform their office, a conſiderable time after the other functions are aboliſhed, part of this quantity will probably be abſorbed during the operation; and therefore about half a pint more (if neceſſary) may be repeated, near the cloſe of the proceſs.

Stimulating Enemas.
Tobacco Smoke—its qualities.

51. Not only the ſtomach, but the inteſtinal tube annexed, conſtituting the alimentary canal, is every where moſt bountifully ſupplied with nerves, by which an intercourſe is carried on with all the principal organs, and propagated to the remoteſt parts of the ſyſtem. This canal, therefore, through its whole extent, may be well conſidered as the centre of ſenſibility and nervous ſympathy; and, conſequently, deſerves particular attention, in all caſes of vital ſuſpenſion. Hence, various ſtimulants have been propoſed for ſupporting its periſtaltic motion, and for rendering it a proper medium for renewing nervous energy, by means of its ſympathy with the other vital organs.

TOBACCO SMOKE injected into the inteſtines by way of enema, having at an early period of the art, been firſt employed in Holland, and its ſucceſs highly extolled, the practice was ſoon adopted in this country, where after various trials, the reſult appeared in ſome meaſure to juſtify the encomiums which had been beſtowed on it.

Accordingly, the practice has been invariably purſued to the preſent time; and the machine for adminiſtering the tobacco enema ſtill conſtitutes a principal part of the apparatus of the different Societies, inſtituted for the recovery of the drowned.

From the well known partiality of the Dutch to this their favorite panacea, Tobacco, and from their long habitual uſe of it, not only as a luxury, but a remedy, there ſeemed reaſon to ſuſpect that its virtues had been over-rated, and perhaps too implicitly relied upon by Engliſh Practitioners. We, therefore, ventured, many years ago, to enter the following *Caveat*, with a view to bring its merit to the teſt of experiment; but without preſuming to paſs judgment upon it, prematurely.

"The ſickneſs and univerſal languor, which theſe fumes produce on other occaſions, when they penetrate beyond the valve of the colon, but ill accord with the idea of reſtoring vital action. So that it may be doubted, whether *theſe effects* of this noted remedy may not *counterbalance* its *ſtimulating* power. The ſame objection may be alſo urged againſt the nauſeating effects of emetics in theſe caſes." *

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* Hints on reſtoring Animation, in 2 letters to Dr. Hawes, publiſhed in his Addreſs to the King and Parliament. p. 20. 1783. Dodſley.

Some late Writers, perceiving the force of the objection, have expreſſed the ſame doubts reſpecting the tobacco enema. Others have ſince, gone much further and condemned it in the ſtrongeſt terms, and that chiefly for the following reaſons. viz.

1st. Becauſe it has been uſed with ſucceſs in the directly oppoſite intention, namely, to relax, as far as is conſiſtent with ſafety, the contractile power of the muſcles, particularly with the view of ſubduing obſtinate coſtiveneſs, or reducing ſtrangulated hernias. It cannot therefore but be a doubtful, if not a very dangerous remedy, where the powers of life are already reduced to the loweſt pitch.

2ly. Becauſe in ſome late experiments, where tobacco ſmoke was injected into the inteſtines of quadrupeds previouſly drowned, the action of the heart and muſcles preſently ceaſed, and irritability, inſtead of being reſtored by this remedy, was ſoon deſtroyed.

3ly. Becauſe the infuſion of a ſingle dram of tobacco injected in form of an enema, with a view to bring on a temporary debility, has been known to produce extreme ſickneſs, vomiting, faintings, and cold ſweats.

4ly. Becauſe 2 or 3 drops of the eſſential oil of this plant, when applied to the recent wound of an animal, have been found to cauſe an immediate palſy of the limb, generally followed by vomitings, convulſions, and death.

5ly. If its fatal oil accompanies the fumes of tobacco into the bowels, what may be ſuppoſed to be the conſequence, where upwards of 2 ounces of this herb are conſumed, in attempting to recover the drowned!

On the other hand, however, it ought to be obſerved, that the advocates for tobacco conſider it not only as a very ſafe remedy, but the principal agent in the recovery. And in confirmation of their doctrine, appeal to the numerous inſtances of its ſucceſs, that have been communicated to the different Societies. They further allege, that it can hardly be ſuppoſed that the reſpective Practitioners could all be ſo ſtrongly prepoſſeſſed in its favor, as to unite in exaggerating its merit, or in palliating its miſchievous conſequences, had any ſuch occurred.

Were its effects really as deſtructive as its opponents affect to believe, it would have been next to a miracle, had a ſingle perſon ſurvived the operation, where it was uſed with ſuch freedom.

Beſides, there are found certain votaries of tobacco, able to conſume daily a larger quantity of the plant than the one above-mentioned, and that without inconvenience:* Others, who as a remedy in complaints

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* Happening ſome time ago to meet a droll character of this ſtamp, a remarkable *quidiſt*, I aſked him, how much tobacco might be his daily allowance?

"About two ounces and a half," ſays he.——I next inquired, complaints of the ſtomach, ſwallow both the ſmoke and the ſaliva in large quantity, without any apparent injury.

That the eſſential oil is highly poiſonous cannot be denied, though certainly in a far leſs degree applied to the bowels than to a wound: The plant, it muſt be confeſſed, is ſtill leſs ſo, and the ſmoke leaſt of all.

The deleterious quality of the oil is alſo probably counteracted, partly by the alkali generated in the combuſtion, and partly by its union with the other component parts of the ſmoke.

On the whole, though the tobacco enema is by no means ſo dangerous as ſome have imagined, yet as it ſtill appears in ſuch "a queſtionable ſhape," it is hoped the following doubts will ſoon be cleared up, not by reaſoning, but by a courſe of accurate experiments. viz.

1st. Whether its ſtimulant or ſedative power is moſt predominant?

2ly. Whether its utility depends on the ſpecific qualities of the plant, or on the warmth and diſtention, which accompany its exhibition? 3ly.

red, whether he was not affraid of chewing every day, ſuch a quantity of a rank poiſon? "*Poiſon*, Maſter," replies he, ſtuffing his mouth with an enormous quid, and eying me with a look of ineffable contempt, "*Poiſon!*—why it is the ſtaff of life—and I can prove it—For a man can live much longer without victuals, than without tobacco."

Then drawing nearer, added he, in a half whiſper—"Did you ever know a man die, Maſter, while able to chew his quid of tobacco?"——Here, rolling his *quid* briſkly, and looking archly—he marched off with an air of triumph—muttering the word "*Poiſon*"—— * * * * * *

3^{ly}. Whether the ſickening and debilitating effects, which generally accompany its operation, are not inimical to ſenſibility and irritability—and whether a bladder of warm vital air, which has been ſhewn to be congenial to both (29—32), might not be advantageouſly ſubſtituted in its place?

But ſince the cauſe of tobacco has been lately ſo very ably defended by our worthy Regiſter, we here drop the pen; for we preſume not to decide "where Doctors diſagree;" and as the cauſe is at iſſue, refer our Readers to—TRANS. of the *R. H. S.* Vol. 1. p. 503.—where the virtues of this much *injured* plant are amply diſplayed, and its re-animating powers nobly aſſerted.

> ——"*Si Pergama dextra*
> *Defendi poſſent, etiam hac defenſa fuiſſent.*"
>
> VIRG. ÆN.

After all, ſhould, an unelaſtic fluid be preferred in this intention, the aromatic vinous cordial abovementioned (48), or either of the following forms might be properly adminiſtered, as a ſtimulating enema.*

Stimuli adapted to the Organs of Senſe.

52. Particular ſtimuli, appropriated by Nature to affect the external organs of ſenſe only, are light to

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* Take of warm water—3 quarters of a pint.
—— of freſh muſtard—half an ounce.
—— of etherial oil of turpentine—2 drams.
The whole to be incorporated with the yolk of an egg.

Or, Take of ſtrong infuſion of horſe raddiſh root—12 ounces.
—— of pure ſpirit of ſal ammoniac—1 dram.

the eye, ſound to the ear, odors to the noſtrils, &c. But during a complete ſuſpenſion of the ſenſorial power, the mind is no longer conſcious of the impreſſion of the wonted ſtimuli; becauſe the brain cannot perform its office without the concurrence of the other vital organs.

Before the ſenſes can be recovered, the neceſſary means muſt be previouſly employed to reſtore reſpiration and circulation. While theſe two requiſite conditions are wanting, ſtimuli applied to the external organs cannot reſtore loſt ſenſation, though they may afford an *uſeful Teſt* to determine whether any degree of ſenſibility ſtill remains. Though they are not always to be depended upon as primary remedies, they may be conſidered as important *auxiliaries.*

Hence, in ordinary caſes of ſyncope, the natural ſtimuli alone often ſucceed in rouſing the torpid powers, without any artificial aid, but more generally require to be increaſed by art, or their intenſity augmented, to produce any ſenſible effect. Though a perſon in profound ſleep is not diſturbed by the tinkling of a ſmall bell, yet he ſuddenly awakes on the ringing of a full peal.

Though the dim light of a ſmall taper may not ſenſibly affect the eye of a drowned perſon, yet the reſplendent blaze of a large candle burning in a jar of vital air, might cauſe the dilated pupil viſibly to contract.

Amongſt the claſs of ſtimulants uſed on thoſe occaſions, it ſeems remarkable that bliſters and ſinapiſms have been paſſed over in ſilence, though evidently entitled to a place among the external applications, eſpecially as they might be eaſily tried, without interfering with the other parts of the proceſs.

One of the moſt active ſtimuli that can be applied to the external organs of ſenſe (electricity perhaps excepted), is the pure volatile alkaline ſpirit already mentioned: the effects of which in recalling perſons from ſudden faintings are much ſuperior to thoſe of hartſhorn, or even the beſt concentrated vinegar.

Therefore a feather, dipt in this penetrating fluid, may be ſucceſſively applied to the different organs of ſenſe, viz. To the angle of the eye, to the cavity of the ear, to a ſlight inciſion in the ſkin, and particularly to the internal ſurface of the noſtrils.

Applied thus directly to the olfactory nerves, unleſs ſenſibility has wholly forſaken them, its ſubtile ſtimulus will be inſtantly propagated to the common SENSORIUM, or centre of impreſſions—an effect not eaſily accompliſhed, perhaps, by any other means.

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SECT. XV.

Compendious View of the Method of conducting the PROCESS.

53. Having thus impartially examined at ſome length the remedies employed by the Humane Societies, and endeavoured to aſcertain their reſpective merits, with a view towards improvement; we proceed to reduce the method of conducting the proceſs into a more compendious form.

In all caſes of apparent death, time preſſes, and the urgency of the caſe demands uncommon expedition. For in this critical ſituation, the vital ſpark, like the laſt glimmering of a taper, at each ſucceeding minute, grows more and more feeble, till the inſtant it expires!—Not a moment then, ſurely, ought to be loſt—

To prevent delay, therefore, by which too many already have periſhed, PROPER HOUSES OF RECEPTION, ſupplied with the neceſſary APPARATUS (43), ought to be eſtabliſhed in every Market-Town, and particularly in all Sea-Ports throughout the Kingdom.—See Dr. Hawes's Addreſs, &c. 1783.

Thus prepared, the moſt efficacious meaſures might be immediately purſued by the Aſſiſtants; not in hurry and confuſion, but with method and regularity, conformable to a well digeſted plan.

As ſoon as the object arrives, all ſpectators ſhould be excluded the room, except thoſe that are abſolutely neceſſary, and which perhaps never need to exceed 7 in all, including the medical Aſſiſtants: two of whom may perform artificial reſpiration, while two more conduct the electrical operation: two others may manage agitation of the body with friction, while another aſſiſts occaſionally and hands the neceſſary utenſils.

A greater number will not only embarraſs the operation, but render the air impure by their reſpiration. If the weather will permit, the windows ſhould be kept open, otherwiſe the temperature regulated between 64 and 70° of Fahrenheit's thermometer.

For the contaminated air of a crowded room, in caſes apparently favorable, may defeat all hopes of ſucceſs, as we have ſeen with regret, in more than one inſtance.

If the ſeaſon be perfectly ſerene, the body may be placed in the open air to receive the genial warmth of the ſolar rays, while the other neceſſary means of recovery are purſued.

The body if wet, muſt be immediately well dried, to prevent the chilling effects of evaporation (20), and then be wrapped in warm blankets, or the warm clothes taken from ſome of the ſpectators, unleſs the cooling proceſs (45), ſhould be firſt neceſſary, in conſequence of the object being in an half frozen ſtate. For in that caſe, it ought to be rubbed with ſnow, or flannels wrung out of cold water, before any degree of artificial warmth can be ſafely applied.

The internal heat muſt therefore be determined in the firſt place, by the thermometer; and the external temperature muſt be regulated accordingly.

Having prepared a bed or mattreſs, on a table of a proper height, the body is to be placed thereon, with the head elevated by 2 pillows; when the different parts of the proceſs may be conducted in the following order.

1st. Let the lungs be immediately inflated by means of the proper inſtruments deſcribed in the Appendix. The operator having paſſed the fore-finger of his left-hand as far into the throat as he can, along this, let him direct the end of the flexible tube (No. 3.) till it has got about 2 inches within the paſſage leading to the ſtomach. Then move the ivory ſliding director along the tube as far as the finger will reach, till it ſecures this paſſage, ſo as to prevent the entrance of air into the ſtomach, allowing the oppoſite end of the tube to hang out of the right angle of the mouth. Let him next depreſs, and draw forward the tongue with the left-hand, while with the right he directs the point of the ſilver canula (No. 2.) along the left ſide of the throat beyond the root of the tongue, till it ſlides into the aperture of the wind-pipe.

Then having ſecured the oppoſite end of the canula to the pipe of the bellows (No. 1.), by means of the leathern mouth-piece (No. 2.), the noſtrils and mouth being accurately cloſed by the aſſiſtant, who ſuſtains the canula in its place; The operator reſting the bellows on his knee, and ſitting behind the patient, endeavours to imitate a full inſpiration, by injecting into the lungs 112 cubic inches of vital air, or if this unfortunately be not in readineſs, common air. When every attempt to introduce the canula into the wind-pipe proves impracticable, recourſe muſt be immediately had to Bronchotomy (45).

2ly. The electrical machine (No. 6.) being prepared, the body inſulated, and the lungs expanded, let one diſcharging rod be placed juſt below the right breaſt, and the other above the ſhort ribs of the left, the electrometer being moved a quarter of an inch from the jar, let the electrical current be paſſed directly through the heart. The electrical ſhock being given, let the lungs be emptied by making an expiration with the double bellows, or by ſuffering the air to eſcape by the mouth, while gentle preſſure is made on the cheſt.

The moment this is accompliſhed, let the lungs again be expanded, and the ſhock repeated, varying its direction, its power, and its frequency, as circumſtances may point out.

3ly. Theſe alternate operations having been duly carried on about 15 or 20 minutes, let the ſtimulating cordial (50) be conveyed through the flexible tube into the ſtomach, by preſſing the vegetable bottle in which it is contained (No. 4.).

4ly. Immediately after this, either of the ſtimulating enemas (51) may be alſo properly adminiſtered, or what would perhaps be preferable, warm vital air (49). The cordial and enema may, if neceſſary, be repeated near the cloſe of the proceſs.

5ly. Theſe internal ſtimulants being given, and bladders of tepid water applied to the region of the ſtomach and to the extremities, the legs and arms muſt be diligently rubbed with the warm hand or with flannel, or a hare-ſkin impregnated with the fumes of gum benzoin. The frictions muſt be gradually extended to the thighs, abdomen, and cheſt.

6ly. Should a warm bath happen to be at hand, the temperature muſt at firſt be very low, beginning at about 40 degrees, raiſing it gradually, and with great circumſpection to 70 or even 80°. During his ſtay in the tepid bath, which may be 15 or 20 minutes, the friction with a warm hand or fleſh-bruſh under water, may be purſued without interruption.

7ly. As ſoon as theſe means of reſtoring heat and ſenſibility have been tried, the internal temperature of the body may again be examined by introducing the thermometer (No. 9.). If the temperature be increaſed, even in the ſlighteſt degree, it affords a good omen, and the operator muſt proceed with all poſſible diligence and circumſpection.

8ly. Particular ſtimuli may next be applied to the organs of ſenſe, as a ſtrong light to the eye, and pungent ſubſtances to the olfactory nerves, eſpecially the pure volatile ammoniacal ſpirit.

Should ſneezing or any viſible emotion enſue, it will be evident that the ſenſorial powers are beginning to recover their ſenſibility.

9ly. Artificial reſpiration and electricity, having been only ſuſpended 15 or 20 minutes during the exhibition of the internal remedies, and tepid bath, are now to be renewed together with friction, and continued at intervals, during the whole time. Electricity may alſo ſometimes be tranſmitted through the ſpine, and other parts of the body; varying the current from poſitive to negative, and from ſparks to ſhocks.

10ly. At that critical period, when ſlight twitchings or gaſpings mark the firſt dawn of returning life, inſtead of increaſing, it will be prudent to moderate the ſtimulating powers, leſt the irritable fibres ſhould be exhauſted by too frequent, or unneceſſary exertion (46).

11ly. The proceſs above-mentioned ſhould be continued the full ſpace of 3 hours, with very few intermiſſions, unleſs the vital functions ſhould be reſtored ſooner.

If, at the end of that period, the unfavorable ſymptoms inſtead of diminiſhing ſhould increaſe, attended with other evident ſigns of the extinction of life (38), the caſe may be conſidered as utterly hopeleſs, and therefore the proceſs may be diſcontinued.

Still, however, before quitting the room, it may not be improper to order a ſtrong bliſter to be applied to the region of the heart, and warm ſinapiſms to the feet, firſt ſprinkled with the volatile alkaline ſpirit.

12ly. Where no medical aſſiſtant can be had in time, the lungs may be inflated, though leſs perfectly by means of the conical tube (No. 5.), or any other pipe adapted to the noſtril, and ſecured at the other end to the nozle of a common pair of bellows, while the mouth and oppoſite noſtril are kept cloſe by an aſſiſtant.

Not only this, but the reſt of the proceſs (electricity perhaps excepted) might certainly without much difficulty be performed by the common people, were they properly inſtructed; ſince it appears that, in Holland, more than half the recoveries of the drowned are brought about by them alone, though, at home, we know but few inſtances of this ſort.—Reports of the *R. H. S.* 1787 to 89. p. 11—13.

13^{ly}. When the natural reſpiration, and the power of ſwallowing are reſtored, the patient ſhould be put into a bed moderately warm, with his head properly raiſed, and his feet wrapped in warm flannel.

Warm whey and other diluents may now be adminiſtered, to encourage a gentle perſpiration. But he ought by no means to be left alone, till he has perfectly recovered his ſenſes: ſome perſons having relapſed, and afterwards periſhed from being deſerted too ſoon, even after the functions were apparently reſtored. Unhappy inſtances of this ſort have been properly noted in the Society's Reports.

14^{ly}. Should feveriſh ſymptoms enſue, accompanied with a ſenſe of heavineſs or dull pain in the head or cheſt (as frequently happens in conſequence of the ſevere diſcipline ſo lately undergone), moderate bleeding together with mild laxatives and a cool regimen will generally afford the deſired relief.

Application of the Plan to the various kinds of Suffocation.

54. From what has been advanced concerning the nature and proximate cauſe of ſuſpended animation (29)—and from the ſimilarity of appearances in all the different modes of ſuffocation, it ſeems evident that the general plan with the improvements propoſed (53) may (with ſuitable variation) be rendered

applicable to all the different ſpecies of the diſeaſe: Not only to caſes of drowning (1), ſtrangulation (6), and ſuffocation from noxious air (7), but alſo to thoſe of intoxication (41), ſmothering (11), and vital ſuſpenſion in children ſtill-born (10). Moreover, it equally applies to the various kinds of ſyncope (46), and ſudden faintings, whether the diſeaſe be brought on by a cloſe crowded room, the hyſterical paſſion, violent emotions of mind, ſtrokes of lightning (46), or expoſure to intenſe cold (20—39).

In that death-like ſyncope, however, occaſioned by thoſe violent floodings to which child-bed women are often incident, or thoſe more dreadful effuſions of blood, under which our gallant ſoldiers and ſeamen ſink down exhauſted in time of battle, a general paleneſs overſpreads the whole ſurface, and the breathleſs body becomes as cold as marble—a ſituation which affords an exception and demands a more than common ſhare of ſkill and diſcernment in the treatment.

In order to recall life as ſpeedily as poſſible, it has been uſual, on thoſe occaſions, to pour down a conſiderable quantity of hot wine, ſpirits, or other ſtimulating liquors, than which, nothing can be more injudicious.

Practitioners ought therefore to be admoniſhed, that the ſyncope is the *dernier reſſource*, which Nature calls to her aid, to ſtop the torrent, and to preſerve life. During this truce, the particles of blood coaleſce into a glutinous maſs to ſeal up the bleeding veſſel. To interrupt this ſalutary proceſs prematurely by heating cordials, is in effect, to renew the effuſion of blood, and to precipitate the patient's fate!

Here, any attempt to reſtore animation by the application of heat, friction, or electricity, according to our general plan, would be equally injurious by increaſing the hæmorrhage. Inſtead of which, the body ought inſtantly to be expoſed to a free current of air, and treated according to the cooling method. If the ſyncope however ſtill continues after the bleeding has ſtopped, or the veſſel been ſecured, prudent meaſures muſt be uſed to reſtore reſpiration. Might not vital air artificially cooled ſupply the moſt innocent, yet animating fluid for that purpoſe? Should this fail to renew the circulation, from the heart being deprived of its due quantity of blood, might not this be repleniſhed from the vein of an healthy animal? If ever the operation of transfuſion can be really beneficial, is not this the proper moment for a trial?

The principal arguments adduced in the preceding inquiry might be illuſtrated by an ample induction from facts, but having already exceeded our preſent limits, this muſt be left to a future opportunity. In the interim, the intelligent Reader will be pleaſed to exerciſe his own judgment, in applying the general principles to particular circumſtances.

E. Penny del.

P. Audinet sc.

Returning Animation.

Engrav'd from the Original, by Permiſsion of the Proprietor.

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APPENDIX.

DESCRIPTION OF THE APPARATUS,

With Hints for additional Improvements.

The Apparatus employed by the Royal Humane Society, and other ſimilar inſtitutions, with their lateſt improvements, may be ſeen at their reſpective inſtrument Makers in London.*

Though many of the articles are liable to ſome ſlight inconveniences, yet all of them may, in ſkilful hands, be made to anſwer the intention.

Were we to propoſe any additional improvements, the apparatus ſhould conſiſt of the following articles. viz.

No. I. In place of an air Syringe, a pair of DOUBLE BELLOWS, with proper valves to perform the double office of inſpiration and expiration, having one department for conveying the pure, and another for excluding the impure air. Of a portable ſize, but ſufficient to convey, at each inſpiration, 112 cubic inches of air.

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* Particularly at Mr. Savigny's, Pall-Mall—Field's, Cornhill—Dickinſon's, Weſt Smithfield—&c.

II. A Silver Canula, of the form of a male catheter, but of larger diameter, adapted to the nozle of the bellows. To be introduced into the orifice of the wind-pipe, for the more effectual conveyance of air into the lungs, or by an opening into the trachea, in caſe of Bronchotomy. The canula may be united to the nozle of the bellows, either by a flexible tube, or a conical mouth-piece of leather, ſecuring the juncture with waxed twine.

III. A Flexible Tube (of the ſame compoſition as flexible catheters), to be introduced into the œſophagus, for conveying into the ſtomach wine or cordials: Having a moveable ivory director of a conical form, at its upper extremity, which by the fore-finger may be made to ſlide along the inſtrument into the opening of the œſophagus; not only to prevent air eſcaping into the ſtomach, but alſo to guide the ſilver canula into the wind-pipe.

IV. A Vegetable Bottle for injecting liquids into the ſtomach, through the above flexible tube; the mouth of the bottle being adapted to the upper end of the tube.

Or the liquor might be poured into the tube through a ſmall glaſs funnel.

V. A Conical Tube of wood or ivory about 4 inches long, adapted to fill the cavity of the noſtril. The oppoſite end being wide enough to receive the nozle of any pair of common bellows, and being lined with ſoft leather, to fit the cloſer, air may thus be conveyed into the wind-pipe, while the mouth and oppoſite noſtril are ſecured by an aſſiſtant. This ſimple apparatus alone, might be uſed by the common people, where medical aid could not be readily had.

Were the tube made forked, it would be ſtill better, as the lungs might then be inflated by both noſtrils at the ſame time.

VI. A SMALL ELECTRICAL MACHINE, with an electrometer annexed, and a coated jar of about 26 inches, compoſed of thin glaſs, together with a pair of diſcharging rods properly inſulated.

VII. VITAL AIR in cylindrical glaſs jars, of a gallon or upwards each, inverted with their mouths downwards in a large tub of lime-water, and well-ſecured from the external air.

VIII. STIMULATING REMEDIES, particularly the pureſt volatile alkaline ſpirit—alſo a ſmall quantity of each of the following, viz. eau de luce, ſalt of vinegar, ſpirit of lavender, tincture of cinnamon, &c. in ſmall phials of ground glaſs, well ſecured.

IX. A SMALL THERMOMETER with a ſliding ſcale, proper for determining animal heat.

X. An Elastic Machine for injecting ſtimulating enemas: alſo a Tobacco Instrument, for conveying the warm fumes into the inteſtines, ſhould the latter be perferred.

XI. Phosphoric Matches, Wax Tapers, Twine, &c.

XII. An Additional Elastic Tube, for conveying vital air from the under part of the jar to the inhaling valve of the bellows, where the orifice muſt be rendered air tight. About the middle of the tube, a ſtop-cock to admit the air during inſpiration, and to intercept it during expiration. The Vital air, if managed with œconomy, may be reſpired 2 or 3 times ſucceſſively, when it will ſtill be found more pure than common atmoſpheric air—being now leſs liable to be contaminated than in natural breathing.

Should the advanced price of nitre render the preparation of vital air too expenſive a remedy, the latter may be obtained by a ſimilar proceſs from manganeſe, wherever that mineral can be eaſily procured. Beſides the air from manganeſe has been lately diſcovered to be of ſuperior quality, and in greater abundance—a circumſtance of no ſmall importance, now that the demand for vital air, on account of medicinal purpoſes, is daily increaſing. Nor is this to be wondered at, ſince the new light, which it continues to reflect on the œconomy has already begun to dawn on the pathology—a circumſtance which ſeems to denote that a material REVOLUTION in the Practice is at no great diſtance.

The whole Apparatus, excluſive of the double bellows, electrical machine, and air jars, may be compriſed in a ſmall portable caſe, ſimilar to that which is employed by the Royal *H. S.*

The ſilver canula and flexible tubes, being ſimilar to thoſe improved ones lately introduced into uſe, ſpecimens may be ſeen at the different inſtrument-makers, where they may be adapted to the double bellows. The reſt may be eaſily conceived, without further deſcription or engravings.

◆

RECAPITULATION,

OR

General Inferences from the Whole.

From the preceding arguments may be drawn the following deductions, which (in order to aſſiſt recollection) are here brought into a more conciſe and perſpicuous point of view.

It ſeems reaſonable to conclude then,

1. That the faculties of Man, compared with thoſe of other animals, or even with thoſe of individuals of his own ſpecies, cannot be explained on the principle of organization, or apparent difference in the ſtructure of the brain.

2. That Man differs from other animals, not only in the extent, but the nature of his faculties—that human reaſon is eſſentially different from animal inſtinct, and that philoſophers have erred in attributing the properties of MIND to Matter.

3. That Vitality is the attribute of an organized being alone, and therefore the blood being an inorganic maſs cannot with propriety be pronounced to be alive.

4. That the vital or animal Principle is not to be conſidered as a ſeparate being, confined to the brain, or reſiding in ſome particular organ.

5. That Irritability, though allowed to be the principle of vitality, requires other conditions eſſential to organic life, to produce the functions of an animated being.

6. That in addition to the other requiſites which conſtitute animal life, Man is endowed with a rational ſoul, the faculties of which diſtinguiſh him from all other creatures, and give him a decided pre-eminence in the ſcale of ſublunary beings.

7. That the eſſence of the Soul, and the nature of its connection with the corporeal frame are wholly unknown, and can only be traced from their effects.

8. That in drowning, a ſmall portion of water generally enters the lungs—that the blood is accumulated in the right chamber of the heart and venous ſyſtem—that the organization of the principal parts remains entire, and the brain free from extravaſation.

9. That in hanging, the phenomena are nearly the ſame, only the veſſels of the brain more diſtended.

10. That ſuffocation from noxious air deſtroys life ſooner than drowning, though the phenomena in general are ſimilar, only in the former, the body remains more flexible, and retains its heat longer—That in either caſe, the appearance of the lungs is uncertain; ſometimes they ſeem collapſed—ſometimes, diſtended—at others, quite natural—The brain alſo free from any ſign of extravaſation.

11. That air is eſſential to all breathing animals—that vital air is the only reſpirable part of the atmoſphere fit to ſupport life or flame—that part of it is expired in form of carbonic air, and part retained in the ſyſtem.

12. That vital air changes the blood in its paſſage through the lungs to a more florid colour—that the blood alternately contracts impurities in its circulation, and is alternately purified by the proceſs of reſpiration.

13. That the heat of the human body preſerves an even ſtandard in infancy and old age, under every variation of climate from the Equator to the Poles.

14. That it is principally, if not wholly dependent on reſpiration and the oxygenation of the blood—

blood—That this is carried on by a curious chemical proceſs, during which a double elective attraction ſeems evidently to take place.

15. That the PROXIMATE CAUSE of death in the various modes of ſuffocation cannot be fairly traced to water imbibed into the lungs, nor a ſurcharge of blood in the brain, or accumulation in the heart, nor yet to a collapſe of the lungs, or defect of latent heat, nor, in ſhort, to any other circumſtance that has hitherto been aſſigned.

16. That the IMMEDIATE CAUSE of SUSPENDED RESPIRATION is the excluſion of vital air from the lungs—That if to this, be added the extinction of irritability, it conſtitutes the PROXIMATE CAUSE of DEATH.

17. That this opinion is not very remote from the truth appears from this, that it affords a key whereby all the principal ſymptoms may be explained.

18. That VITAL AIR affords an eaſy explanation of many intricate phenomena in Nature, particularly in the animal œconomy, which otherwiſe would appear inexplicable.

19. That SENSIBILITY and IRRITABILITY, though generally confounded, are diſtinct in their

nature and in their origin—that the former depends on the nerves, the latter on a property peculiar to the muſcles.

20. That the heart gives the firſt indication of irritability, and beſides other peculiarities, retains it longer than the other muſcles.

21. That VITALITY conſiſts in action and re-action, between the vital organs and their reſpective ſtimuli—that the irritable fibre is never paſſive, but in a conſtant ſtate of action.

22. That in nicely adjuſting ſtimuli to the due tone of the irritable fibre conſiſts the PRINCIPAL SECRET in the art of healing.

23. That irritability is ſtronger in the loweſt order of animals than in Man—that this compenſates for their want of ſagacity—that the final cauſe is the preſervation of life.

24. That vital air is eſſential to irritability, and may be conſidered as its PROXIMATE CAUSE—that this was FIRST hinted by the Writer in 1783, though lately brought forth by ſome other authors, as a DISCOVERY ENTIRELY NEW.

25. That the effects of irritability, and the action of chemical ſtimuli admit of a more ſatisfactory ſolution from this, than from any other cauſe.

26. That the MECHANISM OF THE BRAIN is NOT the proximate cauſe of mental operations, but only the inſtrument by which the human SOUL is deſtined to perform its functions through a corporeal organ.

27. That the SENSIBILITY of the ſyſtem depends on the different degrees of excitement of the brain, and of the ſentient extremities of the nerves.

28. That irritability is not dependent on the ſame cauſe as ſenſibility, as Profeſſor Cullen ſuppoſed, ſince it prevails among the vegetable tribes deſtitute of brain and nerves.

29. That irritability alone is ſufficient to illuſtrate the periodical revolutions, and other ſingular phenomena of plants, without having recourſe to a PERCEPTIVE faculty which implies INTELLECT.

30. That the daily expenditure of vital air is amply repleniſhed by a powerful combination of natural powers during the preſence of the ſun.

31. That this explains why ſerene ſun-ſhine gladdens all Nature, and why darkneſs if too ſudden, or too long continued depreſſes the ſpirits, and is unfriendly to health.

32. That, with ADMIRABLE ŒCONOMY, the

different parts of Nature are rendered at once ſubſervient to the mutual ſupport of each other, and the general HARMONY of the WHOLE!

33. That ELECTRICITY and HEAT bear a ſtriking analogy to each other, and yet differ materially in ſome reſpects—That the former, from the celerity of its movements, and from its effects being SIMULTANEOUS, is more peculiarly adapted to explain the phenomena of the nervous ſyſtem.

34. That although the perfect identity between this and the nervous influence has not been demonſtrated, yet ſome late experiments tend to confirm it. Not to mention that the torpedo and gymnotus evidently poſſeſs a certain ſpecies of electricity, over which they have complete command.

35. That the NERVOUS ELECTRICITY ſeems ſubject like irritability to accumulation, diminution, and tone—that from theſe different ſtates may be explained many curious phenomena of the nervous ſyſtem, which otherwiſe would appear extremely myſterious.

36. That the nervous influence was attributed to the principle of electricity by the Author more than a dozen years ago—that the doctrine therefore of nervous electricity, which now makes ſo much noiſe in

the philoſophical world, and which Galvani's experiment tends powerfully to confirm, is not ſo entirely *new* as is commonly imagined.

37. That in DROWNING, certain circumſtances haſten on the fatal event, while others tend to protract it—that NO certain CRITERION of the preſence or abſence of life can be drawn from any *ſingle* ſymptom—that this however may generally be determined from a certain *aſſemblage* of ſigns conſidered collectively.

38. That NATURE'S PROCESS IN RESTORING ANIMATION, and the extent of her reſources ought to be previouſly known, before we can appreciate the efficacy of artificial means.

39. That the TORPID STATE of certain dormant animals bears a ſtrong reſemblance to apparent death from drowning or ſuffocation—that they are revived by moderate warmth, but deſtroyed by ſudden heat.

40. That in vital ſuſpenſion, the two PRINCIPAL INDICATIONS are to reſtore RESPIRATION, and the ACTION of the HEART—that if theſe two primary organs can be brought to act in uniſon, the ſubordinate movements will generally follow in ſucceſſion.

41. That VENESECTION, though apparently indicated, is a very doubtful, and even dangerous operation, and ought not to be hazarded, at leaſt till the circulation be reſtored.

42. That EMETICS are alſo very dubious remedies, and can rarely be neceſſary on thoſe occaſions, unleſs immoderate repletion previous to the accident ſhould be known to interrupt the general proceſs.

43. That ARTIFICIAL RESPIRATION is an important part of the treatment, and ought to be performed at the beginning, and purſued till natural breathing can be re-eſtabliſhed—that its effects will be more certain and expeditious if conjoined with ELECTRICITY.

44. That VITAL AIR, recommended by the Writer long ago, has been found preferable to atmoſpheric air, or air blown from another perſon's lungs, for the purpoſe of artificial reſpiration.

45. That COMMON NITRE involves in its ſubſtance the baſis of gun-powder and vital air—two oppoſite principles, the former deſtined to deſtroy, the latter to preſerve human life.

46. That, not only medical pupils, but other intelligent perſons, in every pariſh, ought to be in-

ſtructed in the method of inflating the lungs—that this may be tolerably executed by the common people, even without the proper inflator, in places remote from medical aid: Alſo other parts of the proceſs, electricity excepted.

47. That the INFLATOR ought to contain 112 cubic inches of air, as a proper quantity for one inſpiration—that the operation ought to be conducted with more preciſion than has hitherto been done.

48. That ELECTRICITY is one of the moſt powerful ſtimulants—that its power ought to be adjuſted to the feeble ſtate of the ſyſtem—that moderate vibrations are more ſafe and efficacious than ſtrong ſhocks—that it ought to accompany artificial reſpiration, though it may be ſafely applied independent of that operation, during any part of the proceſs.

49. That HEAT is eſſential to animal and vegetable life, and therefore has been employed as one of the moſt powerful means of reſtoring animation—that it requires however much caution, and ſeldom ſucceeds alone unleſs reſpiration be previouſly reſtored—that it ought to be carefully regulated by the internal heat of the body.

50. That, inſtead of artificial heat, the Ruſſians apply SNOW OR COLD WATER to the apparently dead body—that this COOLING METHOD, howe-

ver paradoxical it may appear, is nevertheleſs attended with ſurpriſing ſucceſs, particularly in caſes of ſuffocation from noxious air.

51. That the USUAL METHODS of communicating heat are very uncertain—that the temperature is fluctuating, ſometimes too little, often too great—that it ought to be adjuſted by the thermometer—that if the internal heat keeps pace with irritability, it may afford a NEW TEST of the preſence or abſence of life.

52. That AGITATION of the body has alone ſometimes ſucceeded in reſtoring vital action—that it affords a ſpeedy mechanical ſtimulus to the whole frame—that it is eaſily performed by the common people.

53. That FRICTION alſo under due regulation is a very uſeful auxiliary in ſtimulating the cutaneous nerves, and in expediting the motion of the blood towards the heart—that the rough manner in which it is often conducted may prove miſchievous—that ſaline, ſpirituous, or unctuous ſubſtances, inſtead of increaſing, tend to diminiſh its efficacy—that it may be beſt performed with the hands, or flannels impregnated with the fumes of gum benzoin.

54. That a ſtimulating CORDIAL is highly neceſſary—that it may be ſafely conveyed into the ſtomach without occaſioning any danger of ſuffocation—that ſpirituous liquors being exhauſting ſtimuli are leſs proper than generous wine with a ſmall addition of ſome cordial tincture, or volatile alkaline ſpirit.

55. That ſtimulating ENEMAS are alſo indicated—that their effects, like thoſe of cordials, are propagated to the other vital organs by ſympathy—that the TOBACCO enema appears to be a doubtful remedy, though not ſo dangerous as ſome imagine—that while it is condemned by ſome, it is ably defended by others—that the cauſe remains *ſub judice*, and waits the reſult of future experiments.—That in the interim, WARM VITAL AIR and other ſtimulants of a leſs equivocal nature might deſerve a trial.

56. That STIMULI adapted to the ORGANS OF SENSE may prove uſeful auxiliaries and afford a TEST whether any degree of ſenſibility remains—that next to electricity, the pure VOLATILE ALKALINE SPIRIT appears to be the moſt active.

57. That in caſes of apparent DISSOLUTION not a moment ought to be loſt—That RECEIVING HOUSES with the neceſſary apparatus as recommended by Dr. Hawes might tend to ſave many lives, and prevent that delay and ſubſequent hurry and confuſion by which numbers are loſt—That the PRO-

CESS ought to be conducted with METHOD and regularity, and with an eye to all the concomitant circumſtances.

58. That the electrical current ſhould be directed through the region of the heart, during the expanſion of the lungs—that a full expiration then ſhould be made, and the ſhock again immediately repeated; varying its power and frequency as circumſtances may point out.

59. That after theſe alternate operations have been carried on 20 minutes, the ſtomachic cordial and ſtimulating enema ought to be adminiſtered.

60. That to theſe, ſhould ſucceed the warm bath, beginning at 40 degrees, and gradually raiſing it to 70 or 80—that where this cannot be had, bladders of warm water may be applied to the region of the ſtomach, and to the extremities.

61. That friction may accompany the operation the greateſt part of the time, even during the tepid bath.

62. That when ſigns of returning life begin to appear, the ſtimulating powers ought to be moderated, leſt the irritable fibres ſhould be exhauſted by too powerful excitement.

63. That the proceſs ought to be continued with patience and perſeverance the full ſpace of 3 hours, or while any hopes remain.

64. That after the functions are reſtored, the patient ought not to be left too ſoon, for fear of a fatal relapſe—but treated according as the ſubſequent ſymptoms may appear to indicate.

65. That the general plan, with ſuitable variations, is applicable to all the different ſpecies of vital ſuſpenſion.

66. That the formidable ſyncope occaſioned by exceſſive floodings or other great and ſudden effuſions of blood, affords an exception to the general method, and demands the utmoſt circumſpection—that the ancient operation of transfuſion might perhaps, on this occaſion, deſerve to be revived.

67. Finally, that the GRAND INTENTION of the WHOLE ARTIFICIAL PLAN is to REMOVE EVERY KNOWN OBSTACLE—to CALL FORTH THE HIDDEN RESOURCES OF NATURE—and ENABLE HER TO RESTORE A FREE RESPIRATION AND CIRCULATION.

❧

CONCLUSION.

CONCLUSION.

It is now time that this Dissertation ſhould draw to a Conclusion, though many topics ſtill remain upon which we could expatiate with pleaſure.

The Theory of Animation preſents a ſpacious field for inquiry, abounding with curious and inviting objects which engage our attention at almoſt every ſtep. But the preſent excurſion has only permitted us to take a ſhort and tranſient glimpſe of that grand aſſemblage, and to ſelect from the number thoſe only that appeared to be moſt worthy of attention.

To ſuch of our ingenious Colleagues as may be inclined to take a larger range, and to contemplate the whole at leiſure, theſe curſory obſervations are cheerfully offered, hoping they may tend in ſome meaſure to facilitate their reſearches.

In the courſe of our inquiry, many difficulties have ſtarted up, and though ſome of them have been ſurmounted, yet others ſtill remain, concerning which we could only offer probable conjectures. Such, however, may ſtill not be without their uſe, though they ſhould even prove erroneous. For if they ſerve only to ſtimulate ſome abler Writer to take up the pen where we are obliged to drop it, (though with no other view than to detect their fallacy) yet ſtill the end will be anſwered.

"*Vice fungar cotis.*"

It is by colliſion chiefly, that thoſe ſparks of Genius are elicited, which contribute to irradiate the darkeſt ſubject, and to point out the direct road to truth.

Since no perſon from the Prince to the Peaſant can at all times be ſecure from thoſe dreadful diſaſters, which ſuddenly ſuſpend vital action; and ſince medical Practitioners themſelves are by no means exempt; it ſurely becomes them to uſe every exertion to IMPROVE the ART OF RESTORING ANIMATION.

May each progreſſive ſtep in this intereſting path of ſcience tend to that GREAT OBJECT! And may every laudable attempt, undertaken with that benevolent view, enable us with MORE CERTAINTY TO PRESERVE LIFE, AND TO DIMINISH THE SUM OF HUMAN MISERY!

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